THE POTENTIAL OF EXPRESS BUS TO SERVE PEAK TRAVEL DEMAND TO OUTLYING EMPLOYMENT CENTERS: A CASE STUDY OF THE ATLANTA REGION

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devoted their time to explaining the agency and their COA to me via emails and a telephone conversation. Second, as a side activity that is not directly related to this thesis, I did ridechecking for GRTA's COA through consultant Metro Planning and Engineering (MPE) in 2014. This experience provided an informal introduction to the experience of riding GRTA Xpress buses. Third, in 2012, when Ms. Beall delivered a guest lecture about GRTA to my transportation planning class, I felt inspired about the potential of express bus, which ultimately led to this thesis. MARTA, which has also conducted a COA, helped by providing me with draft plans, via contact person Kelly Hayden.

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LIST OF ABBREVIATIONS

ABM	Activity-Based Model
ARC	Atlanta Regional Commission
ASC	Alternative-Specific Constant
BRT	Bus Rapid Transit
CC	Centroid Connector
CCT	Cobb Community Transit
COA	Comprehensive Operational Analysis
CT-RAMP	Coordinated Travel – Regional Activity Based Modeling Platform
EL	Express Lane
GCT	Gwinnett County Transit
GDOT	Georgia Department of Transportation
GP	General Purpose
GRTA	Georgia Regional Transportation Authority
GSU	Georgia State University
HE Holmes	Hamilton E. Holmes
KSU	Kennesaw State University
MARTA	Metropolitan Atlanta Rapid Transit Authority
MIW	Motors Industrial Way
MPO	Metropolitan Planning Organization
NJT	New Jersey Transit
P&R	Park and Ride
TAZ	Transportation Analysis Zone
TBM	Trip-Based Model (a.k.a. four-step model)

TIP	Transportation Improvement Program
TPB	Transit Planning Board
TTI	Texas A&M Transportation Institute

SUMMARY

This thesis investigates the potential of express bus to serve travel demand in a polycentric region, using the Atlanta metropolitan area as a case study. Express bus serves as the primary mode of line haul transit commuting for most suburbs in the Atlanta region. Routes mainly serve the suburb-to-city commute. However, over the past half century, much employment has taken shape in the suburbs, such that the majority of commutes are to suburban locations (Zuehlke, 2007), and counterintuitive congestion patterns result. Commuting markets to the suburbs are underserved by transit. This thesis investigates the potential to give express bus a more polycentric focus.

Applying the trip-based travel demand model of the Atlanta Regional Commission (ARC), four scenarios are run. The first three are preliminary, testing baseline results for the years 2015 and 2020 as well as short term plans from the Georgia Regional Transportation Authority (GRTA) and the Metropolitan Atlanta Rapid Transit Authority (MARTA). The final scenario builds off of these short term plans and specifically focuses on serving suburban employment. Various service strategies are applied, mainly intermediate stops on existing routes and integration with local transit.

With short term plans from GRTA and MARTA, express bus trips increase by 25%, and overall transit ridership increases by 3,500 trips per day. In the final scenario, ridership improves even more dramatically, such that express bus trips increase by another 50%, and overall transit ridership increases by an additional 8,000 trips. The model shows intermediate suburban express bus stops and circulator routes to be highly

used. Express routes that were kept nonstop actually decreased in ridership. The results support the need and the potential for express bus to serve polycentric travel demand.

CHAPTER 1

INTRODUCTION

Congestion and air quality have been long-standing issues in the Atlanta metropolitan area. In 1998 the Atlanta region did not meet federal clean air standards, leading the United States federal government to freeze funding for road building until a plan was developed to bring the region back into compliance (Gravel, 1999; Hartshorn, 2009) . In response, the Georgia Regional Transportation Authority (GRTA) was created. Falling under Georgia's governor, the authority "addresses mobility and air quality in metro Atlanta," covering 13 counties (GRTA, n.d.-d). One of its functions is to deploy express buses, branded Xpress, that serve long-distance commutes. This service began in 2004 (GRTA, 2015c). Other transit agencies in the Atlanta region have also run express or freeway-based buses (MARTA, GCT, CCT, GRTA, & ARC, 2012a).

Express buses, though, predominantly serve traditional suburb-to-city work commutes (MARTA et al., 2012a). Yet, only 20% the region's workforce takes this commute (Zuehlke, 2007). Over the past half century, employment moved from the central city to the suburbs, following residential migration trends. New edge cities have emerged, including Perimeter Center, Cumberland, and Alpharetta (Hartshorn, 2009). Other significant employment centers include Atlanta's international airport and Druid Hills (Wittman, 2014). Yet, the commuting markets to these locations are underserved by

premium[1] transit. Congestion patterns resulting from these markets are significant, such that they cannot be ignored. Additionally, in the central city, population growth has been exceeding employment growth, resulting in a rise in reverse commuting (Hartshorn, 2009). This market could greatly benefit from premium transit service. Some premium service currently exists for outlying employment centers, yet there is significant room for growth.

Express bus could fill gaps in premium transit service to outlying employment centers. While other technologies have been proposed for regional transit in Atlanta over the years, express bus has the potential to serve as a solution that can be implemented in the near future. Unique challenges exist when running bus service to the suburbs, such as car-oriented roadway designs, superblock street networks, a lack of density, and a high supply of free parking. Yet, enough travel demand exists that express bus should be considered, both as an alternative to driving in congestion and a means of increasing person throughput. The essential question is whether and how express bus can still be effective in serving these markets.

This thesis will investigate the potential for express bus to serve commutes to outlying employment centers. It will supplement Comprehensive Operational Analyses (COA's) currently being undertaken by transit agencies in the region, such as GRTA (GRTA, 2015a) and the Metropolitan Atlanta Rapid Transit Authority (MARTA) (MARTA, 2014a). The analysis of this thesis will primarily be based on the trip-based travel-demand model of the Atlanta Regional Commission (ARC), retrieved directly from the Commission via email (S. Lewandowski, personal communication, 2015). The

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[1] Premium transit, as defined in the travel demand model of the Atlanta Regional Commission (ARC), consists of express bus, bus rapid transit (BRT), heavy rail, light rail, commuter rail, and streetcar (Atlanta Regional Commission, 2010).

findings will have implications for polycentric transit service in the Atlanta region and metropolitan areas facing similar circumstances.

CHAPTER 2

BACKGROUND

2.1 Context of Atlanta

2.1.1 History

2.1.1.1 Planning the Suburb-to-City Commute

With growth in automobile usage during the 20th century, residents in the City of Atlanta migrated to the suburbs. Planning thus focused on doubling Downtown employment and bringing workers into the city (Hartshorn, 2009). Indeed, during the 1950's, "downtown employment dramatically expanded" (Hartshorn, 2009). Hence, skyscrapers were built, and other buildings were demolished to make way for surface parking (Hartshorn, 2009). Plans assumed that suburban residents would commute to the city for work by automobile.

Freeways were being constructed at around this time, based on the principle of "all roads lead downtown" (Hartshorn, 2009). The freeway segment that most resembles this principle is the Downtown Connector. The Connector is a north-south merging of two Interstate highways, I-75 and I-85, that runs alongside of Downtown. In the 1960's, planners projected intolerable traffic conditions resulting from the suburb-to-city commute, such that in 1970 the Connector would need to have a minimum of 46 lanes (Hartshorn, 2009)!

Fortunately, while freeways in the Atlanta region are still relatively wide, the Connector was not widened nearly to that degree. The Downtown Connector ranges from 10 to 16 lanes (Central Atlanta Progress, n.d.), about 25% of the proposed width. Yet, the Connector avoids complete gridlock for much of the day. The morning commute from the

north to Downtown on the Connector itself generally experiences only mild-to-moderate congestion. Similar conditions are true for the commuting from Downtown back to the north in the evening (Google, 2015f). Some credit for this lack of congestion can be attributed to the centrally-focused MARTA heavy rail system and express bus systems, discussed later. However, more likely, it is due to another phenomenon that began taking place in the 1960's that is described by Hartshorn: decentralization of employment (Hartshorn, 2009).

2.1.1.2 Employment Decentralization

Employment followed population migration to the suburbs for practically the same reason – the attractiveness of owning more space at a lower cost. Additionally, workers benefit from the convenience of living close to their jobs. Employment has clustered into new centers, creating "edge cities". These centers include Midtown, Buckhead, Perimeter Center, Roswell/Alpharetta, and Cumberland (Hartshorn, 2009). Other employment centers have formed over time, including Druid Hills and Hartsfield-Jackson Atlanta International Airport (referred hereinafter as Airport) (Wittman, 2014). Employment since has expanded even further into the suburbs, turning the Atlanta region into an "edgeless city" (Hartshorn, 2009).

The significance of outlying employment centers is so great that counterintuitive congestion patterns result. While commuting from the north to Downtown on the Connector in the morning is relatively free-flowing, commuting in the reverse direction is not, as seen in Figure 1. In the evening, the northern merge of I-75 and I-85, heading south toward Downtown, is very heavily congested, while northbound congestion away from Downtown is only moderate (Google, 2015f). Additionally, as seen in Figure 2, heavy congestion regularly results on the northern part of I-285, a beltway circling the city, also known as the Perimeter (Google, 2015g). Ironically, beltways were constructed to allow cars to bypass center city congestion, but unanticipated development occurred

that would induce congestion on these beltways (Jones, 2008). The mainline freeways outside of the Perimeter generally experience more congestion than inside the Perimeter (Google, 2015h).

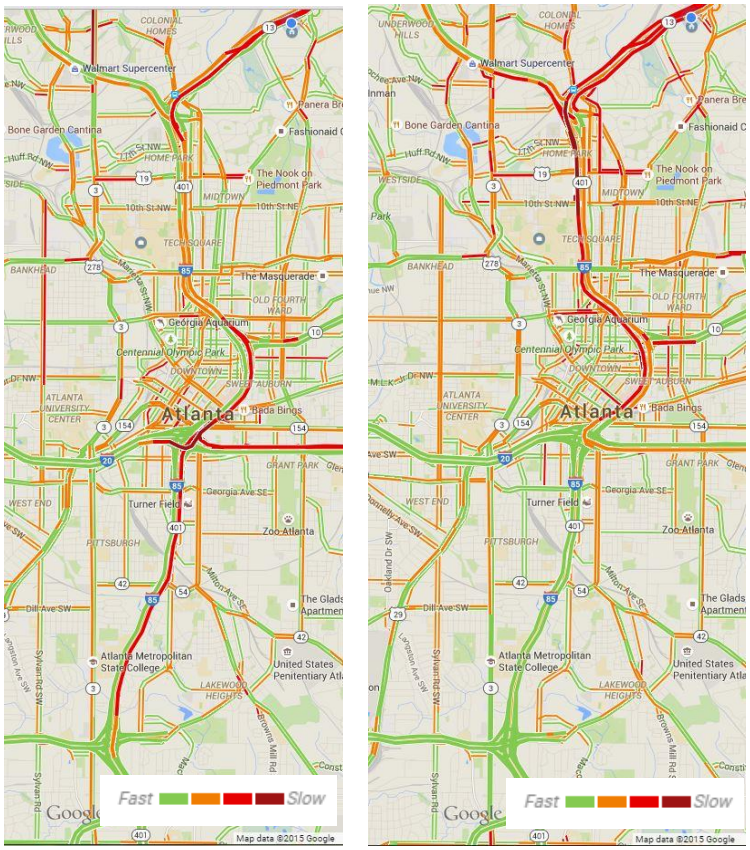

Figure 1: Typical congestion on the Downtown Connector – AM and PM peaks, respectively (Google, 2015f)

Table 1 below shows a breakdown of commuting patterns from the year 2000, with nearly 60% of commutes going to suburban locations (Zuehlke, 2007). Congestion and travel demand patterns clearly show the Atlanta region to be polycentric.

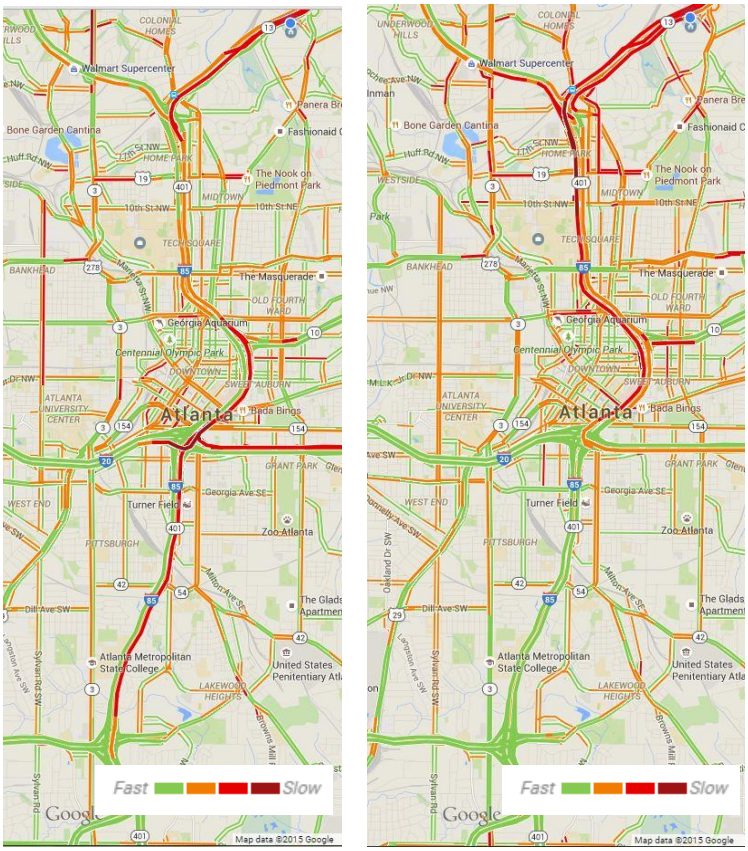

Figure 1: Typical congestion on the Downtown Connector – AM and PM peaks, respectively (Google, 2015f)

Table 1: Breakdown of Commuting in the Atlanta Region - Year 2000 (Zuehlke, 2007)

Commute Type	**Share**
Suburb-to-suburb	53%
Suburb-to-central	20%
Central-to-central	13%
Central-to-suburb	5%
Other	9%

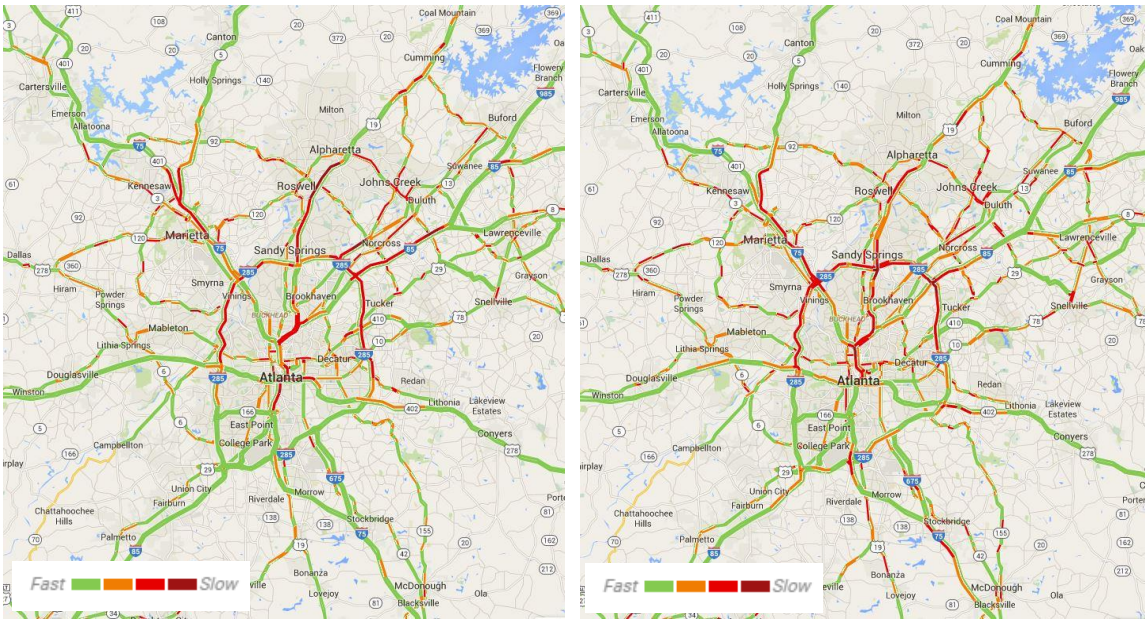

Figure 2: Metro Atlanta typical congestion for the AM and PM peaks, respectively (Google, 2015h)

2.1.1.3 Transit in Atlanta

Despite the growing polycentrism of the region, transit planning has largely been focused on serving traditional suburb-to-city commutes for half a century. In the 1960's, a new transit agency, the Metropolitan Atlanta Rapid Transit Authority (MARTA), began to form. In the 1970's, it purchased the existing local bus system, the Atlanta Transit System, integrated bus routes with the new heavy rail lines (MARTA, n.d.-e) (Hartshorn, 2009). These lines were centered on Five Points in Downtown (MARTA, 2015c), the original center of the city of Atlanta (Ambrose & NGE Staff, 2015). MARTA's development was based on a report projecting Downtown growth to continue rapidly accelerating, despite the decentralization that already began to take place (Hartshorn, 2009). MARTA may have even been conceptualized as a means of refocusing employment growth Downtown. However, when the heavy rail system was built, employment decentralization was well under way, and MARTA did not have significant influence in reshaping that (Hartshorn, 2009). The layout of the heavy rail system, in

addition to mainline highways, is designed to serve the traditional commute from the suburbs to the central business district (CBD) (Hartshorn, 2009), even though that commute represents only 20% of the region's commuting patterns (Zuehlke, 2007).

The MARTA system was planned to serve five inner counties in the Atlanta region – Fulton, DeKalb, Cobb, Gwinnett, and Clayton. However, the measure only passed in two of those counties – Fulton and DeKalb (Hartshorn, 2009). This further limited MARTA's potential. The other three counties eventually introduced their own bus systems (CCT, n.d.-a) (Gwinnett County Board of Commissioners, n.d.) (Snyder, 2014). Cobb and Gwinnett, two northern counties that experienced high growth in population and employment (Cobb County Government, 2002) (Gwinnett County Government, 2015), each began their systems with express bus and followed with local bus (TTI, 2012) (TPB, 2008). In 2004, in response to a federal funding crisis over air quality, a new agency, known as the Georgia Regional Transportation Authority (GRTA), began running express bus service in the region's other counties – Clayton, Coweta, Douglas, Forsyth, Henry, and Rockdale. It later would supplement the premium transit already existing in Fulton, Cobb, and Gwinnett Counties (TPB, 2008). Express bus has filled a void where rail is lacking. Yet, even more than the rail system, it has been focused on serving the traditional suburb-to-city commute. While this commute market remains vital to serve, other commuting markets are significant and deserve increased attention.

2.1.2 The State of Express and Rapid Transit in the Atlanta Metro

While transit in Atlanta is primarily geared toward serving the traditional suburb-to-city commute, the degree to which this generalization holds varies across the four transit agencies. The MARTA system does relatively well at serving edge cities within its jurisdiction. The MARTA rail lines have stations in Perimeter Center, Buckhead, the Airport, and more. Furthermore, several two-way bus routes run on GA-400 from North Springs to the Roswell/Alpharetta (MARTA, n.d.-c). MARTA currently is planning fixed

guideway transit on the GA-400 corridor that is intended to make commutes to these areas even better (MARTA, 2015d). The MARTA system employs a strategy that is praised by Brown and Thompson, such that bus routes feed into nearby rail stations rather than all go to the CBD. This more easily allows passengers to access a variety of destinations (Brown & Thompson, 2009a). This thesis author agrees that this feeder strategy is an improvement. The overall system, though, is still centered on suburb-to-CBD travel, as Hartshorn points out (Hartshorn, 2009). Changes will be tested that may make it better able to serve commutes to suburban centers. However, arguably, MARTA is ahead in polycentric orientation, and ideas from MARTA will be tested for the other systems.

The other three agencies – Cobb Community Transit (CCT), Gwinnett County Transit (GCT), and GRTA – operate one-seat, non-stop[2] express bus service from suburban park-and-ride (P&R) lots to central Atlanta. Most routes go to Downtown, although a good number go to Midtown (CCT, n.d.-b) (GCT, n.d.-c) (GRTA, n.d.-b) (Brown & Thompson, 2009a). Four GRTA routes connect suburban P&R lots to outlying centers (Perimeter Center, Peachtree Corners, Johns Creek, Lindbergh Center, and North Springs) (GRTA, n.d.-b). Furthermore, several reverse commute routes exist. CCT runs three routes – two to Cumberland to one to Marietta and Town Center (CCT, n.d.-b). It also runs a robust all-day route, the CCT 10, connecting Marietta, Cumberland, and Arts Center on Cobb Parkway and I-75 (ARCADIS, 2015) (CCT, n.d.-b). GCT runs one reverse commute route to Sugarloaf Mills (GCT, n.d.-c). In the GRTA system, most routes have reverse commute versions, but they simply are non-stop return trips to

[2] The term "non-stop" is used to mean no stops along the freeways between the origin P&R lot and the employment center. Some routes combine P&R lots, such as the GRTA 411 from Gwinnett County (GRTA, n.d.-a) (GRTA, n.d.-b), but generally speaking, service is non-stop.

suburban P&R lots[3] (GRTA, n.d.-b), and so ridership appears to be sparse. GRTA will soon cut nearly all of its reverse commute routes (A. Poznanski, personal communication, 2015).

In the middle of this 2010 decade, several transit agencies in the Atlanta region have been conducting comprehensive operational analyses (COA's). That is, they have been reviewing practically all aspects of their systems and devising improvements. GRTA and MARTA are both in the latter stages of completing their COA's (GRTA, 2015b) (MARTA, n.d.-d) (K. Hayden, personal communication, 2015). CCT is expected to begin its COA this year (Cobb County Government, 2014). In the immediate horizon, GRTA, based on its COA, plans to streamline its routes in Downtown, combine routes and add frequency, and add new service to Perimeter Center from the northern suburbs (Nelson\Nygaard, 2015d). MARTA plans to make changes to its North Fulton express buses, as well as many local buses throughout its jurisdiction (K. Hayden, personal communication, 2015). GRTA refers to its near-term plan as Horizon 1 (Nelson\Nygaard, 2015d), and MARTA calls its plan Phase 1 (K. Hayden, personal communication, 2015). Collectively, we refer to these plans as Stage 1. Such changes would take place within the next couple of years, and they will improve polycentric connectivity.

Transit in the Atlanta metro, though, has the potential to improve on this even further. In this thesis, express bus is targeted, as it is a flexible, high-speed technology that can operate on the existing freeways. Building off of Stage 1 plans, this thesis investigates strategies and models a plan that seeks to maximize efficiency from both the perspectives of the users and the transit agencies.

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[3] Some GRTA reverse commute routes have intermediate stops along the way. For example, the reverse GRTA 442 route stops at Southern Regional Medical Center.

2.1.3 Commuting Studies in the Region

Study 1: Paper from Nelson, Guensler, and Li – 2008

In the summer of 2006, Nelson, Guensler, and Li assessed freeway commuting patterns in the Atlanta region using license plate data. They established several observation points in the northside during the morning peak and traced license plate numbers back to the addresses at which the vehicles were registered. The study targeted traditional suburb-to-city commuters. However, inferences can be made for commutes to other destinations. Four observation points were analyzed in the paper, with three being just before the I-285 Perimeter on the I-75, GA-400, and I-85 corridors, and the fourth being at the merge point of I-75 and I-85 into the Downtown Connector (Nelson, Guensler, & Li, 2008).

For the I-75 observation point, it was found that most commuters come from eastern Cobb County (Nelson et al., 2008). This result is striking for several reasons. First, it seems to make more sense intuitively for those commuters to use GA-400 instead. However, access across the Chattahoochee River into Fulton County is limited (Nelson et al., 2008). Second, there is no transit in East Cobb, as the CCT system is focused along the I-75 corridor and to the west of it (CCT, 2015a). Third, the findings would justify a new P&R lot near the upcoming Roswell Rd. express lane interchange with I-75, as GRTA wishes to do in its longer-term Horizon 2 Plan (Nelson\Nygaard, 2015e). Parking at the existing Marietta P&R lot may be “out of the way” for those coming from East Cobb. For this thesis, a consolidation strategy that imposes a transfer is tested, so the inconvenience for East Cobb riders could be increased unless a P&R lot east of I-75 is built. This is the only proposed P&R lot in the scope of this thesis, which is justified by this literature source. For the GA-400 and I-85 corridors, existing P&R lots seem to serve adequately the spatial distribution of trip origins, as the P&R lots are close to the freeway.

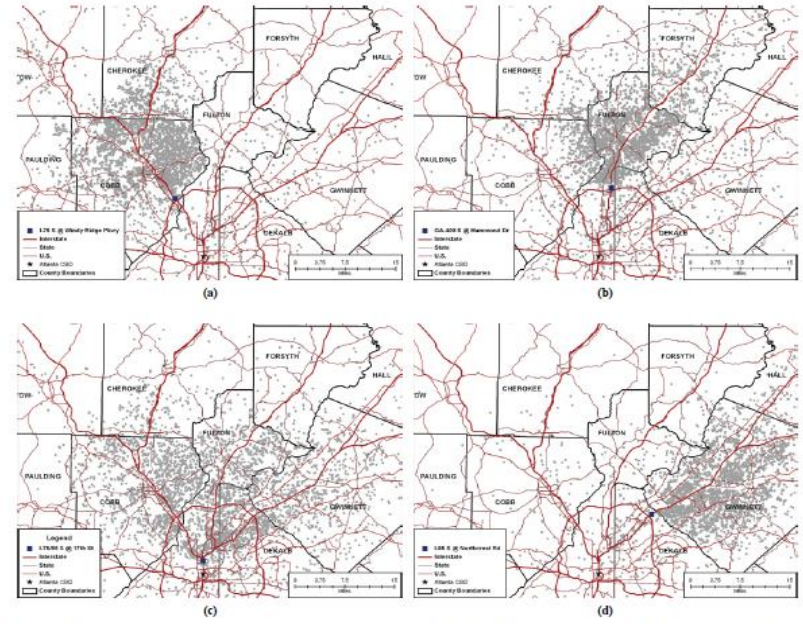

FIGURE 5 Commutersheds for individual Interstate observation sites: (*a*) I-75 SB at Windy Ridge Parkway (n = 4,410), (*b*) GA-400 SB at Hammond Drive (n = 4,952), (*c*) I-85 SB at Northcrest Road (n = 3,605), and (*d*) I-75–I-85 Connector SB at 17th Street (n = 4,405).

Figure 3: Commutersheds for the northern freeway corridors. (Nelson et al., 2008)

Study 2: I-85 Transit Study

Earlier in this 2010 decade, the Gwinnett County Department of Transportation and consultant Atkins North America conducted a transit study pertaining to the I-85 northeast corridor. Part of the study was assessing home-based work (HBW) trips, both in 2010 and 2040, both into and out of the study area. Public meetings were held in early 2012. Figures from presentation materials showing HBW travel demand are below (Atkins North America, 2012).

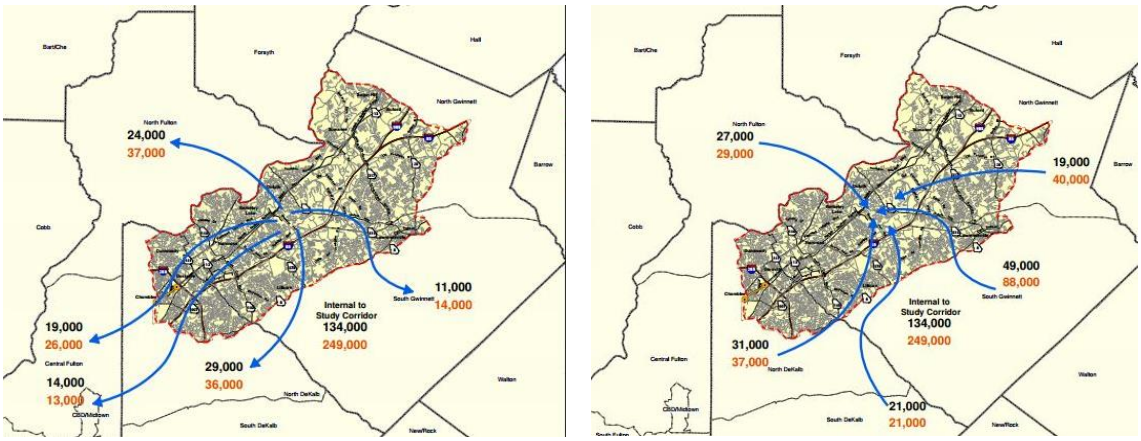

Figure 4: HBW productions and attractions I-85 transit study (Atkins North America, 2012)

The figures show that trips to central Atlanta are expected to be relatively low and decline into the future. Work trips to the nearby suburbs are high and expected to increase dramatically in the future. The majority of HBW trips are internal to the study corridor. Interestingly, both in 2010 and 2040, work trips *to* the study corridor are shown to exceed work trips *from* the corridor. Notably, the reverse commute from central Atlanta to the corridor is not taken into account. Nonetheless, this study supports express bus service to this corridor with intermediate stops.

Study 3: GRTA Market Analysis

As part of its COA, GRTA investigated potential markets for Xpress bus service. The process consisted of identifying potential employment centers and analyzing travel demand to these centers. Three data sources were used to identify demand: (1) travel demand model from the Atlanta Regional Commission (ARC), (2) mobile phone data from AirSage, and (3) Longitudinal Employer-Household Dynamics (LEHD) program of the US Census Bureau. Focusing on eight centers, and taking into account existing MARTA service, potential markets were identified from existing P&R lots and central Atlanta (Nelson\Nygaard, 2015c). The markets to centers outside of central Atlanta, as shown in Figure 5 and Figure 6, are:

1. **North Point –** from Cumming and central Atlanta.
2. **Cumberland –** from the I-75 NW corridor and central Atlanta.
3. **Buckhead –** from Indian Trail and Panola Road.
4. **Druid Hills –** from Stone Mountain and Panola Road.
5. **Perimeter Center –** from all over the northern Atlanta suburbs.
6. **Airport –** all-day demand for all trip types all over the Atlanta metro[4]. Work trips from the southside and Panola Road.

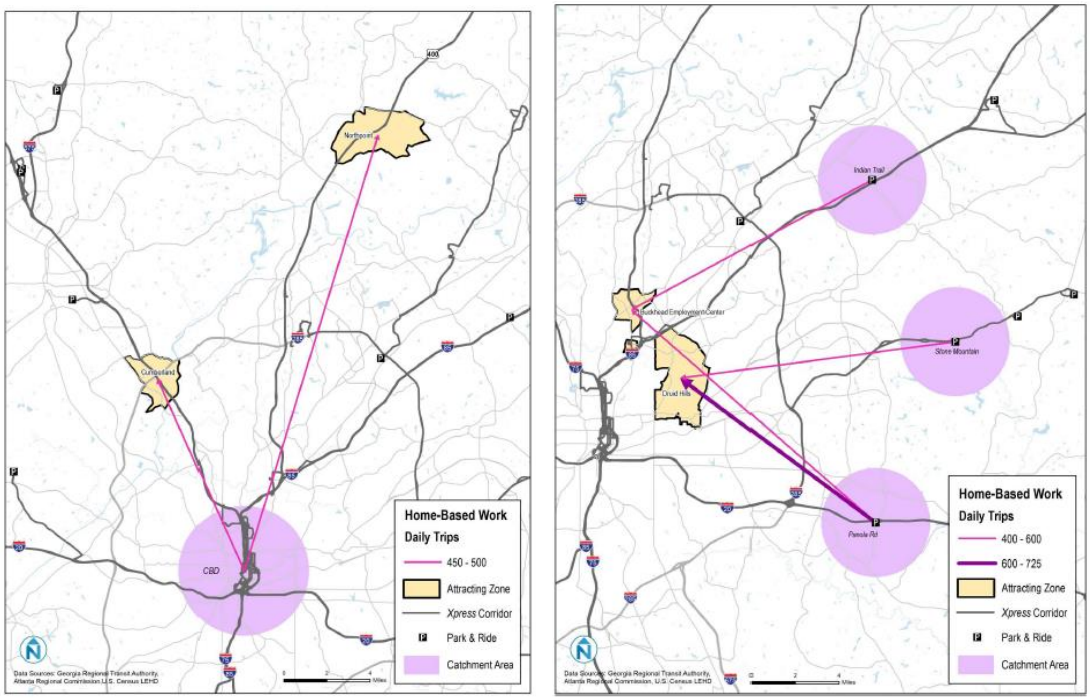

Figure 5: Reverse commute and Buckhead / Druid Hills markets, respectively (Nelson\Nygaard, 2015b)

[4] A graphic from a November 2014 presentation to GRTA's Technical Advisory Committee (TAC) shows demand to the Airport also occurring from Mableton and the US-78 East corridor. Additionally, trip volume estimates differ in this graphic (Wittman, 2014)

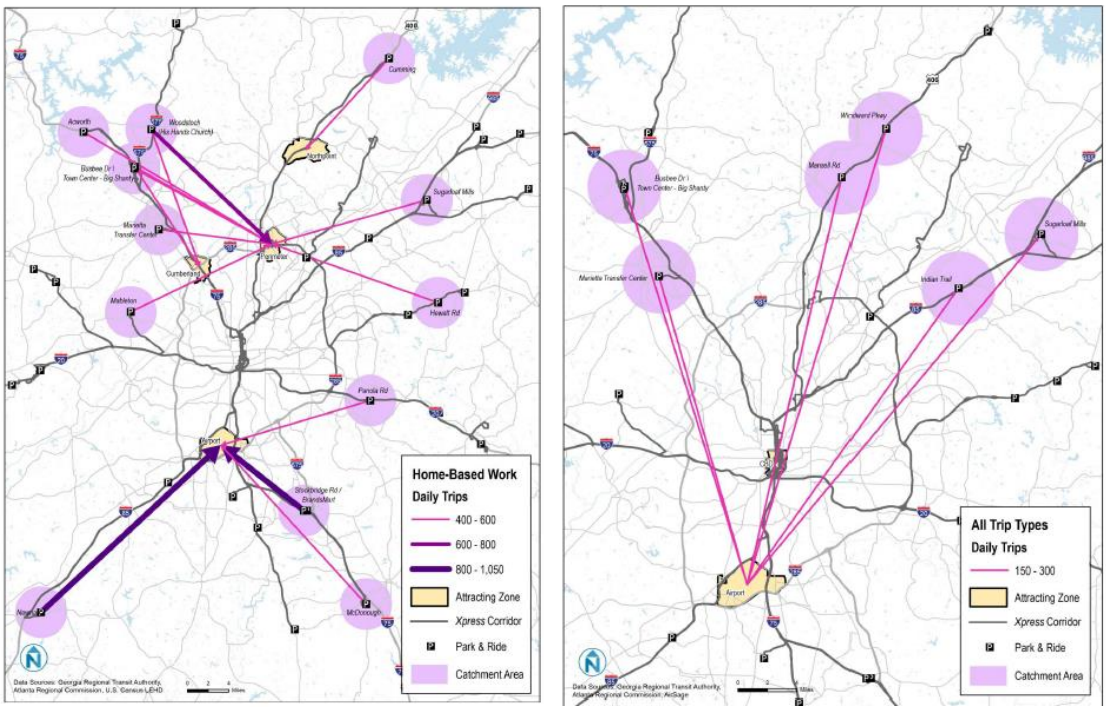

Figure 6: Suburb-to-suburb work markets and other markets to airport, respectively (Nelson\Nygaard, 2015b)

Transit service exists for these markets, though to varying degrees. On one end of the spectrum, direct freeway service exists for reverse commuters to Cumberland (CCT, n.d.-b), though it could be improved. On the other end, existing service is virtually non-existent, such as from Cumming to North Point (MARTA, GCT, CCT, GRTA, & ARC, 2012c). This thesis will place heavy emphasis on providing or improving service to these identified markets.

The report also identified two new markets to Downtown (where P&R lots do not yet exist) and one new market Midtown market from Riverdale (Nelson\Nygaard, 2015c). The latter market will be addressed in the scope of this thesis via small changes to existing routes.

The market analysis report includes appendices with the original desire lines. One strong market, as captured via mobile phone data is from Johns Creek to Perimeter Center, as shown below (Nelson\Nygaard, 2015a). It appears to have been cut from

GRTA's market identification due to the lack of a P&R lot at Johns Creek. Because service from Johns Creek to Doraville already exists (GRTA, 2013), though, the express bus network can be modified to allow Johns Creek riders to transfer to a route bound for Perimeter Center.

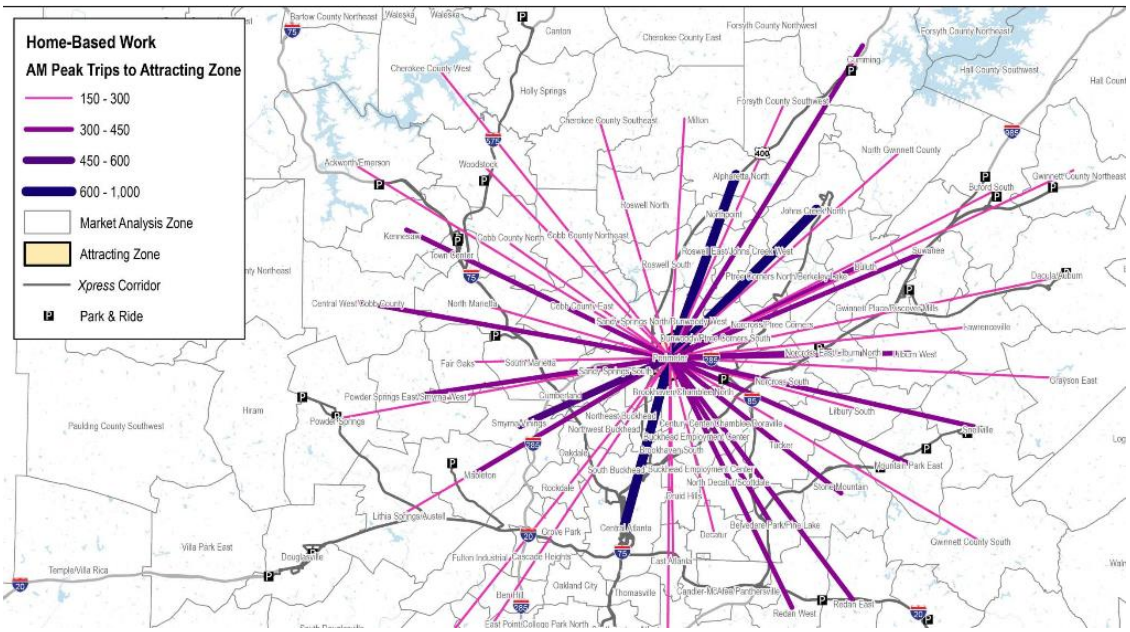

Figure 7: Mobile phone data showing AM Peak HBW demand to Perimeter Center (Nelson\Nygaard, 2015a)

Other potential centers that the report identified, before it narrowed down, include Sugarloaf Mills, Town Center, Southlake Mall, and Fulton Industrial (Nelson\Nygaard, 2015c). For the first two, while GRTA did not include them in the final analysis, it will be adding them as intermediate stops on some of its buses in Horizon 1, as they also are P&R locations (Nelson\Nygaard, 2015d). This thesis will consider additional service to these centers. Additionally, it will consider "low-hanging fruit" changes to provide service to the latter two centers.

2.1.4 Employment and Population in the Atlanta Region

OnTheMap

The tool OnTheMap from the United States Census Bureau shows areas of high population and high employment by census tract. Images from this tool are shown below depicting (1) the top 25 employment census tracts in the Atlanta metropolitan statistical area (MSA) and (2) the top 10 residential census tracts in the city of Atlanta. The former shows potential suburban areas to serve with express bus, while the latter shows potential residential areas in the city of Atlanta to target for the reverse commute. The shade of blue darkens as the estimate increases. The images are to be interpreted carefully, as employment and population estimates are not normalized by census tract size (U.S. Census Bureau, 2011), yet they still provide useful leads.

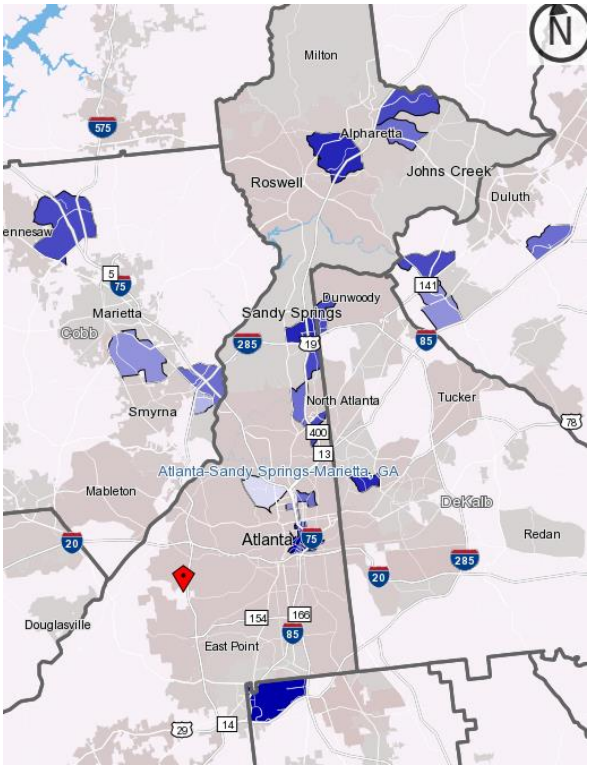

Figure 8: Top 25 employment census tracts in the Atlanta MSA (U.S. Census Bureau, 2011)

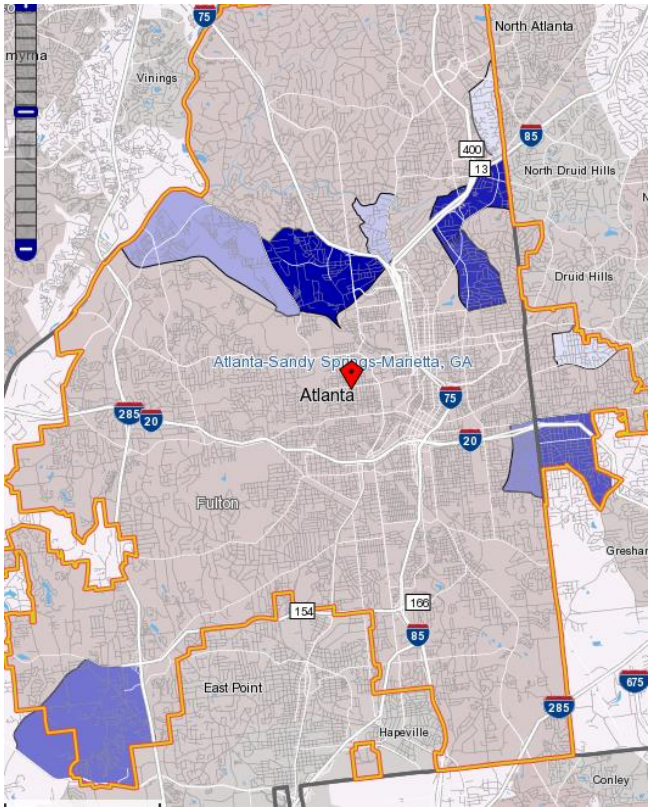

Figure 9: Top 10 residential census tracts in the City of Atlanta (U.S. Census Bureau, 2011)

ARC Regional Centers

In a document called Transportation Assessment, part of *The Atlanta Region's Plan*, the Atlanta Regional Commission (ARC) presents a map of regional centers, shown in Figure 10 (ARC, 2015). This map solidifies knowledge of employment areas in the region.

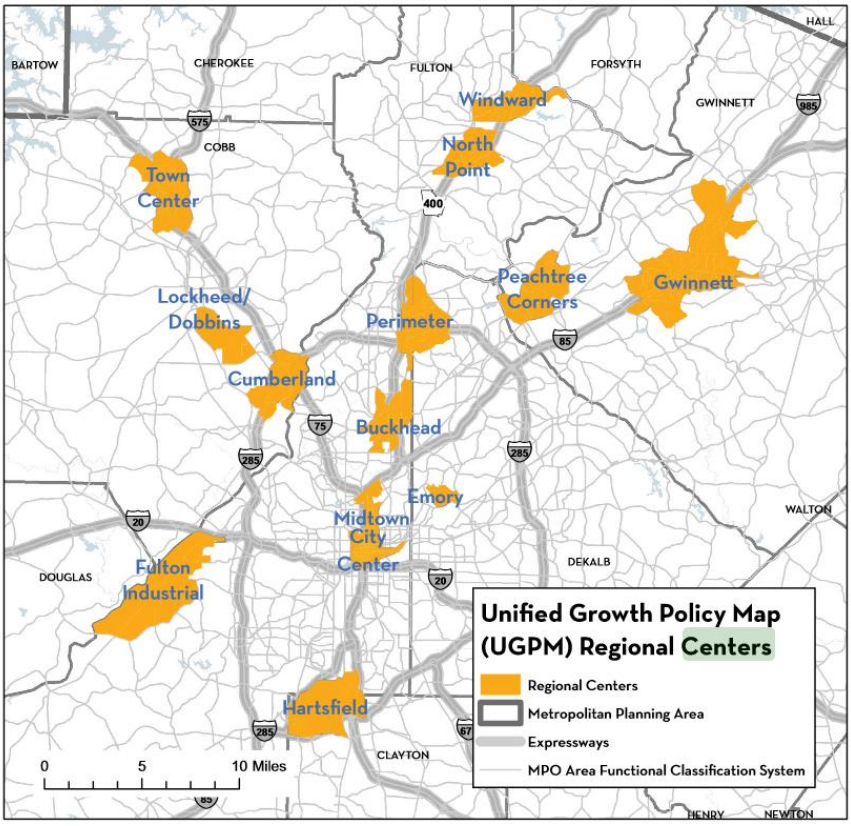

Figure 10: Regional centers as presented in ARC's Transportation Assessment (ARC, 2015)

2.1.5 ARC's Regional Transit Vision

ARC has included a comprehensive regional transit plan in its long-term PLAN 2040, called Concept 3. This Concept incorporates all modes whose technology ranks above that of local bus. The plan is highly polycentric (ARC, 2014). This thesis will simply focus on express and local bus. Express bus would fill roles served by other modes in this plan. The plan that the author devises and models, which is discussed in Chapters 4 and 5, is relatively constrained. However, elements of Concept 3 are incorporated, as later discussed.

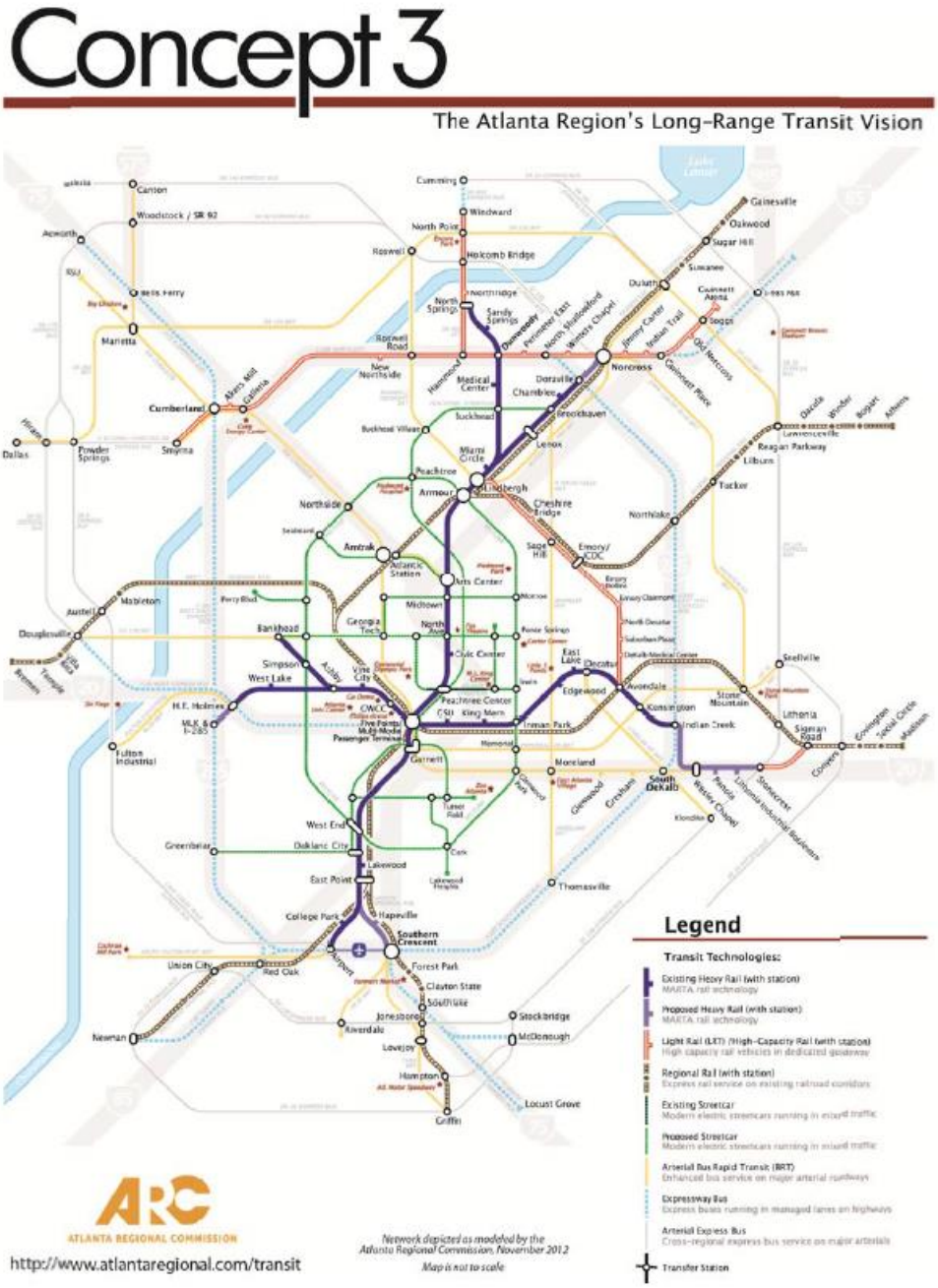

Figure 11: ARC's Concept 3 regional transit plan (ARC, 2014)

2.2 Literature Support for a Polycentric Service Strategy

Hartshorn's Book Chapter

The motivation for this thesis largely came from a need identified in a book chapter by Truman Hartshorn called "Transportation Issues and Opportunities Facing the City of Atlanta." In this chapter, he tells the history of Atlanta's transportation in the 20th century and describes current issues facing the city, as of its 2009 publication (Hartshorn, 2009). He conceptualizes the region as having "barbell growth," in which growth is occurring both in the city of Atlanta and in the exurbs (Hartshorn, 2009). He discusses how the MARTA and GRTA Xpress bus systems are radially focused into Downtown. Despite the growth in reverse and crosstown commuting, those markets are not well served. Recent population growth in the city has "far outpaced employment expansion," and thus, reverse commuting can be expected to "explode in the future" (Hartshorn, 2009). He calls for express bus providing direct connections to edge cities. The jobs-housing mismatch between the north and south sides results in a traffic dilemma. Traffic flows from south to north in the morning and then from north to south in the evening. The author calls for express bus routes from the southside to the northside (Hartshorn, 2009). He further writes, "Since the downtown only accounts for 10 percent of regional employment totals, the upside potential of attracting more radial transit trips to the area remains limited" (Hartshorn, 2009). Furthermore, he writes that expanded shuttle service is needed (Hartshorn, 2009). This chapter provided context to an initial thesis interest in using transit to address freeway congestion. It seems to suggest that much of the region's congestion comes from HBW travel demand to suburban locations that are underserved by transit.

GRTA's market analysis, though, does not show enough market demand to provide service from the southside to the northside that bypasses central Atlanta (Nelson\Nygaard, 2015c). While the demand that does exist likely aggregates into

congestion, the origin-destination pairs of travelers are likely too dispersed. However, this thesis will investigate enhancements in reverse commute express routes and local bus routing in suburban centers. Such changes are expected to improve the transit commute from southside to northside, as riders can transfer in central Atlanta. Additionally, as Hartshorn proposes, direct connections to edge cities will be in the scope of this thesis.

Brown and Thompson

Brown and Thompson have several publications advocating for a "multidestination" service strategy, as opposed to being oriented toward the CBD. The travel demand that is not centrally focused is significant. In a guidebook, they compare many cities and find better productivity for multidestination service strategies (2009b). In a paper, they compare the bus system of Broward County, Florida, with that of Fort Worth, Texas. They find that Broward County's multidestination system outperforms the CBD-focused system of Fort Worth. Additionally, they note that Broward County saw better performance in its system when it was reoriented from CBD-focused to multidestination (2012). The prevalence of polycentric travel demand today makes necessary the reorientation of transit service.

A smaller, but still significant, piece of Brown and Thompson's philosophy is the use of "rail backbone(s)" (2009a, p. 53) The authors, comparing transit productivity metrics between cities, argue that local bus should feed into rail backbones, as opposed to existing as standalone routes (2009b). They praise the MARTA system as being "multidestination" with a "rail backbone" (2009a, p.53). Where the MARTA system falls short, they argue, is that more rail backbones have not been added with the outward growth of the Atlanta region. They provide a map of where new rail backbones can exist, based on census tracts with high employment density. This map is shown in Figure 12 (2009a).

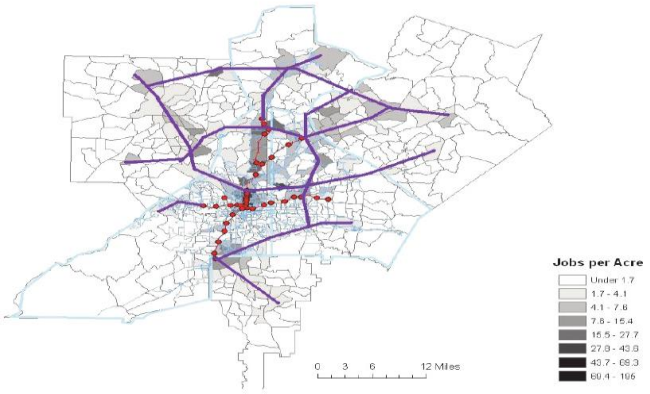

Figure 12: Potential new rail corridors that Brown and Thompson outline based on census tract employment density (Brown & Thompson, 2009a)

This thesis author shows partial and conditional acceptance to the rail backbone idea. He argues that the backbone technology does not need to be rail per se, but some longer-distance premium transit mode. Express bus can serve this role. Notably, many of the drawn rail backbones already exist as express bus routes, yet they lack intermediate stops. Changes that this author will investigate include having intermediate stops and local transit to take riders to their final destinations.

Brown and Thompson also discuss express bus and make specific mention of GRTA. They criticize Xpress buses for bypassing suburban employment centers and going straight to the "shrinking CBD" (2009a, p. 53), thereby attracting a "modest ridership" of 219 passengers per route (2009a, p. 48). They also have compared express bus systems between different cities. While they note a significant amount of added travel time for intermediate stops along the freeway, they argue that this is the best approach, citing Minneapolis and San Diego as examples (2009a).

Finally, they emphasize the importance of transfers. They state that transit systems that try to avoid transfers end up making them undesirable for those that do need to transfer (2009b). They specifically criticize the Atlanta region's express bus services for avoiding transfers and claim that they are "informed by erroneous data on transfer

rates and other aspects of travel behavior" (2009b, p. 79). Planning for transfers makes the system best able to serve a variety of destinations while minimizing inconvenience to the passengers.

Cervero's Suburban Gridlock

This book was written in 1986, though it has been reprinted in recent years and has applicability to today. The entire book is based on the phenomenon of congestion in the suburbs, which was unexpected given that people migrated there to escape congestion in the city. Cervero discussed strategies to mitigate suburban congestion, including some that involve transit. The model that he proposed consists of activity centers with timed transfers. Edmonton is a model for this approach (Cervero, 1986). Application of the approach to this thesis will be complex, considering that metro Atlanta's transit consists of express bus, local bus, heavy rail, and more. Nonetheless, this thesis is centered on activity centers (employment centers), which would be used as transfer points.

Jarrett Walker's *Human Transit*

This book is written by a practicing transit planner and discusses elements of a good transit system. One such element is the orientation of transit into a grid, such that most users will have one connection[5]. Grids can be rectangular or radial. By taking this approach, as opposed to providing direct service for every origin-destination pair, frequency can be increased (Walker, 2012), which maximizes the "freedom" of a transit service (Walker, 2012, loc. 1290). While the book is not academic, it is respected in academia, such that Watkins wrote a book review on it. In the review, she questions the

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[5] Walker emphasizes the use of the term "connection" as having a better connotation than "transfer." This thesis author, though, believes that connotations evolve from experiences, so he generally uses the term "transfer" throughout the paper.

favorability toward connections, as they are disruptive to those who wish to do work while riding, but she notes that "his example of direct service versus connective option (pp. 150-152) powerfully illustrates the rider time savings that comes with more frequent service available by using connections" (Watkins, 2012, p. 102). She also writes, "I tend to agree with him that our current travel demand models shy away from connections by assuming "transfer penalties" that may be much too aggressive in situations where connections are short in duration and seamless in execution, as seen more often abroad" (2012, p. 102).

Walker describes three types of connections: geometrically required, technologically required, and politically required. The first type is when, for example, one transfers from an eastbound route to a northbound route. Walker makes clear that if a local bus feeds into a rail or express bus line, it is still a geometrically required connection, even though the passenger changes the transit technology. A technologically required connection, in contrast, is when two transit routes run in the same direction, but one needs to transfer simply due to the change in technology (Walker, 2012). For example, when the GA-400 MARTA express buses end at North Springs Station (MARTA et al., 2012c), it creates a technologically required connection, as riders are expected to transfer to the Red heavy rail line. These MARTA express buses appear to serve as an interim substitute for extending the Red Line, which MARTA is actively pursuing (MARTA, 2015a). Politically required connections occur when one needs to transfer due to a change of political boundary (Walker, 2012). Geometrically required connections seem to be the most functionally advantageous from the perspectives of both the user and the transit agency. Technologically and politically required connections arguably should be minimized.

This thesis seeks to re-envision express bus away from its one-seat ride approach. Working with connections is complex with express bus, as it is a freeway-based technology. If known market demand involves the use of two freeways, such as from

Town Center to Perimeter Center, then that demand simply should be served by a single express bus route. Transfers between express buses, though, can occur to serve less common markets, such as from North Point to Town Center. For most users, the routing plan tested would involve at most one transfer – taking place in the employment center from express to local bus.

This thesis does rely on a travel demand model with a transfer penalty. For drive-to-transit riders, whom express bus primarily targets, the transfer penalty is 10 minutes of in-vehicle travel time (IVTT). (For walk-to-transit riders, the penalty is five minutes) (ARC, 2011). This is a dramatic improvement from the previous model version, which gave express bus transfers a penalty of roughly 40 minutes (ARC, 2011)! The transfer penalty will be taken into account when making routing decisions. Effective use of geometrically required connections, though, is prioritized, even if model results may drop. Further research will be recommended for effectively modeling transfers.

Thesis on Montreal's Champlain Bridge

This master's thesis from a McGill University student, Armstrong, illustrates the under-recognition of polycentric travel demand in another metropolitan area. In Montreal, in an effort to relieve congestion on the Champlain Bridge, a new commuter rail line was proposed that was bound to the CBD. At the time of the thesis, a lane on this bridge was dedicated to express bus. That lane would be converted to a general purpose lane upon completion of the rail line. The student criticized the plan, showing that most CBD-bound commuters, in fact, used transit. The majority of the traffic on the bridge was really bound to suburban employment locations (Armstrong, 2005). This phenomenon seems to resemble what takes place on Atlanta's Downtown Connector and mainline freeways approaching the I-285 Perimeter from the outer suburbs.

Paper on Charlotte's express bus system

This paper by Presutti and Hartgen was written modeling Charlotte's express bus system, which was radial. With growing suburban centers, the Charlotte Department of Transportation (DOT) proposed a new express bus network providing crosstown connections between hubs. The plan also included local circulator bus service within the hubs. Presutti and Hartgen modeled the potential effectiveness of this plan (1999). They found that new service alone would "add little to system ridership" and "substantially increase the system deficit" (1999, Abstract). However, "if existing service was also expanded along with the hub circulator service, ridership would expand substantially" (1999, Abstract). That is, existing service would be doubled (1999). The authors appear to be including new crosstown express bus service as well in this scenario that they found would be successful. GRTA's Horizon 1 plan does arguably improve service to central Atlanta, as well as provide new service to Perimeter Center. Its plan does not include circulator service though (Nelson\Nygaard, 2015d), as that appears to be a responsibility of local transit agencies. Cobb County does plan to add circulator bus service in Cumberland (Cobb County Government, 2015), though the only freeway-based service that goes there is from central Atlanta (CCT, n.d.-b). This does not change in GRTA's Horizon 1 plan, although its Horizon 3 plan does mention the possibility of making an intermediate stop there for proposed all-day service if the design of the upcoming managed lane ramps allow for it (Nelson\Nygaard, 2015e). This thesis proposes building on Stage 1 plans with intermediate stops and frequency increases on existing routes (mostly bound to central Atlanta), as well as propose new routing to suburban employment.

2.3 Concluding Remarks

With suburban jobs representing a large share of the region's employment, there is a need to provide high-speed transit to employment centers that are outside of the city

of Atlanta. This is especially true with the rise in reverse commuting, as population in the city of Atlanta is growing more quickly than employment. GRTA and MARTA each have conducted COA's and have planned improvements for their buses, to be implemented in three stages. These improvements address the need to provide express bus service to suburban employment. However, these plans can be enhanced, which will be the basis of the thesis. MARTA also has rail construction plans to serve suburban employment. This thesis will explore a precursor to rail construction, based on express buses using the existing roadway. CCT and GCT service will be studied as well. This precursor will build off of near-term plans from GRTA and MARTA, mostly seeking to maximize the efficiency of what is existing while providing the polycentric transit service that is need in the Atlanta region.

CHAPTER 3

METHODOLOGY AND PRELIMINARY SCENARIOS

To explore the effectiveness of transit routing changes, the trip-based model (TBM) of the Atlanta Regional Commission (ARC) is used. This is commonly known as a four-step model. This model was retrieved directly from ARC through email (S. Lewandowski, personal communication, 2015). Four scenarios of this model are run: two baseline scenarios, a scenario with Stage 1 changes, and then a final scenario with changes proposed by the author.

The two baseline scenarios are those that contain already-existing plans. The first scenario is for the current year 2015, while the second is for the future year 2020. These scenarios are almost entirely coded by ARC. The author made minor changes to reflect current and anticipated transit routing more accurately. Running these two scenarios will provide insight into expected trends over the next five years.

The year 2020 was chosen as the future year for this thesis, as that is a time by which changes proposed by the author may be able to be implemented. Because changes deal with mixed-traffic buses running on existing or already-planned infrastructure, construction costs and time would be relatively small. Yet, a few years would still be needed to raise funding, gain public support, refine the details of the plan, and implement the plan. Like the second scenario, the latter two scenarios tested will also be in future year 2020.

The third scenario tests short term plans resulting from GRTA's and MARTA's Comprehensive Operational Analyses (COA's). Both agencies divide their plans into three stages. GRTA calls these stages Horizons, and MARTA calls them Phases. This thesis uses the term Stages to refer to them collectively. The first Stage is expected to be implemented within the next couple of years (K. Hayden, personal communication, 2015)

(Nelson\Nygaard, 2015f). GRTA's Horizon 1 plan mainly involves restructuring express bus service to central Atlanta and providing new service to Perimeter Center from the northern suburbs. New service strategies are tried, such as consolidation of routes with enhanced frequency and adding intermediate stops at park-and-ride (P&R) lots. Notably, the Horizon 1 plan is structured to operate on the same budget as existing service (Nelson\Nygaard, 2015f). Changes that require additional expenses are saved for Horizons 2 and 3 (Nelson\Nygaard, 2015g). MARTA's Phase 1 plans mostly are planned for local bus, though they include significant changes for express buses to Roswell / Alpharetta. All Phase 1 plans are coded into the Stage 1 scenario, though the analysis will focus on express bus.

Stage 1 plans will be a step toward a more polycentric express bus focus and coincide with the research of this thesis. Additional improvements that the author devises will be tested in the fourth scenario, called the Experimental Scenario. Experimental Scenario plans will build off of Stage 1 plans. Additionally, the results of Stage 1 will inform the planning of the Experimental Scenario.

Results will be presented at the regional level and route level. For the final scenario, they also will be presented at the node level. For route and node-level results, the scope is limited to the peak hour.[6]

In summary, the four scenarios will be:

1. 2015 Baseline
2. 2020 Baseline
3. 2020 Stage 1
4. 2020 Experimental

Details about the TBM used to test these scenarios can be found in Appendix A. The first three scenarios are collectively referred to as the Preliminary Scenarios. The

[6] Raw results that include off-peak measures can be provided upon request.

methodology and results of these scenarios are described in this chapter. In Chapter 4, the plan for the Experimental Scenario is described, and the results are presented in Chapter 5.

3.1 Explanation of Each Preliminary Scenario

3.1.1 2015 Baseline

This scenario models conditions in the present year. ARC provided the author with the 2015 model files after this year's Transportation Improvement Program (TIP) Amendment to Plan 2040 (S. Lewandowski, personal communication, March 10, 2015). The transit files show new local bus routes that MARTA has planned to implement this year in Clayton County. Minor adjustments are made to express bus routes in the model so that they best reflect the routing and frequency found on the websites of the respective transit agencies (CCT, n.d.-b) (GRTA, n.d.-c) (MARTA, n.d.-a) (GCT, n.d.-b). A detailed list of changes can be found in Appendix B.

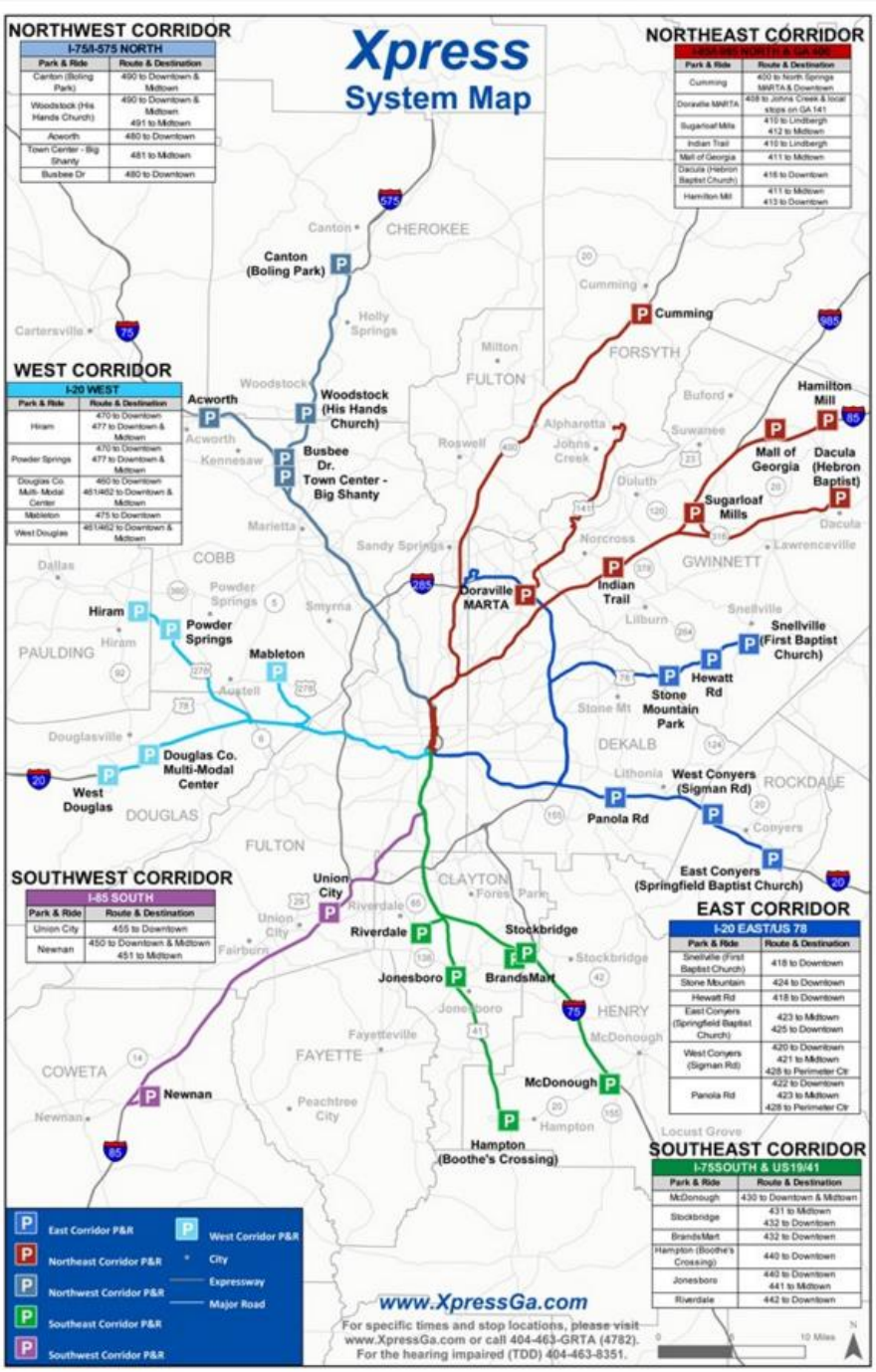

Figure 13: GRTA Xpress map for 2015 and 2020 Baseline (GRTA, n.d.-c)

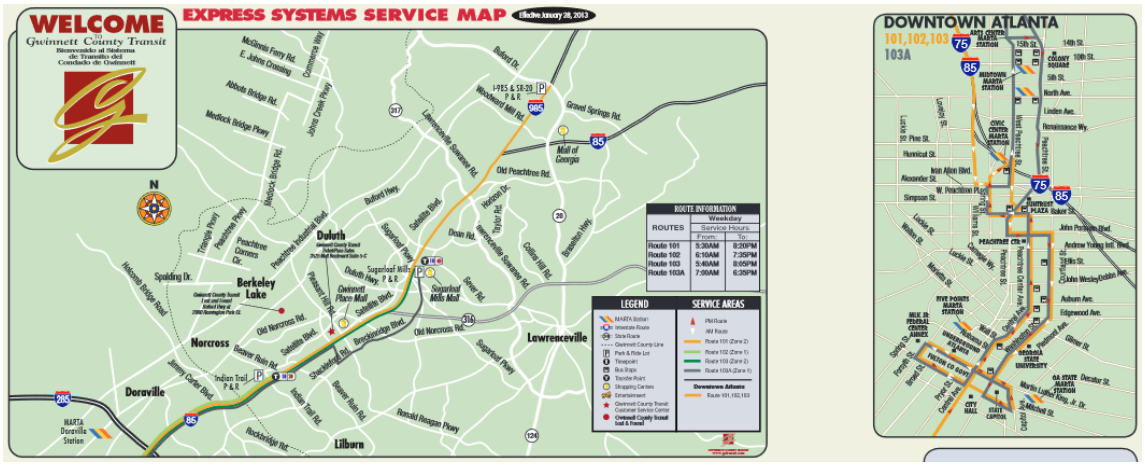

Figure 14: GCT express bus map for 2015 and 2020 Baseline (GCT, n.d.-a)

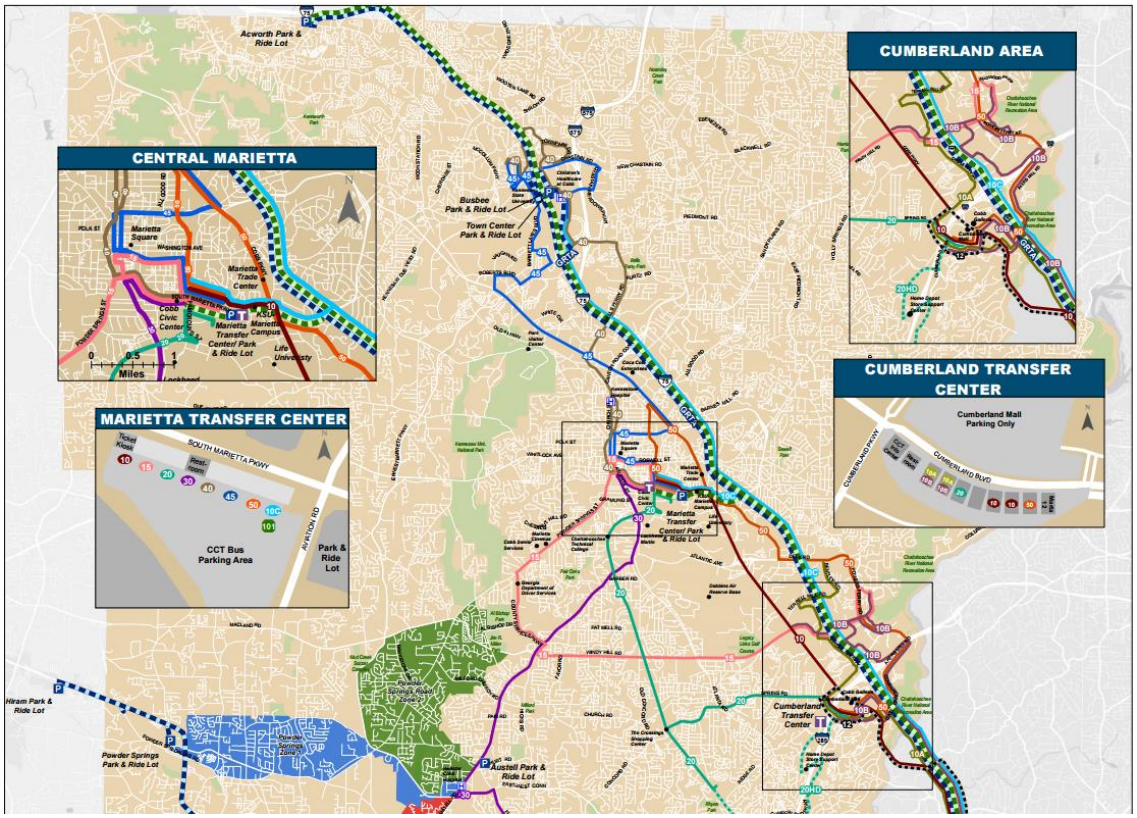

Figure 15: Snapshot of part of CCT system map showing express routes (CCT, 2015b). Inbound express routes are dashed lines, with green being CCT routes and blue being GRTA routes that are operated by CCT (CCT, 2015b; Wittman, 2015). The 10C reverse commute express route is in light blue (CCT, 2015b). This is for the 2015 Baseline scenario. The 2020 Baseline scenario is similar, yet the 10C does not stop in Marietta, a new Cumberland circulator exists, and the inbound I-75 express buses run on the express lane facility.

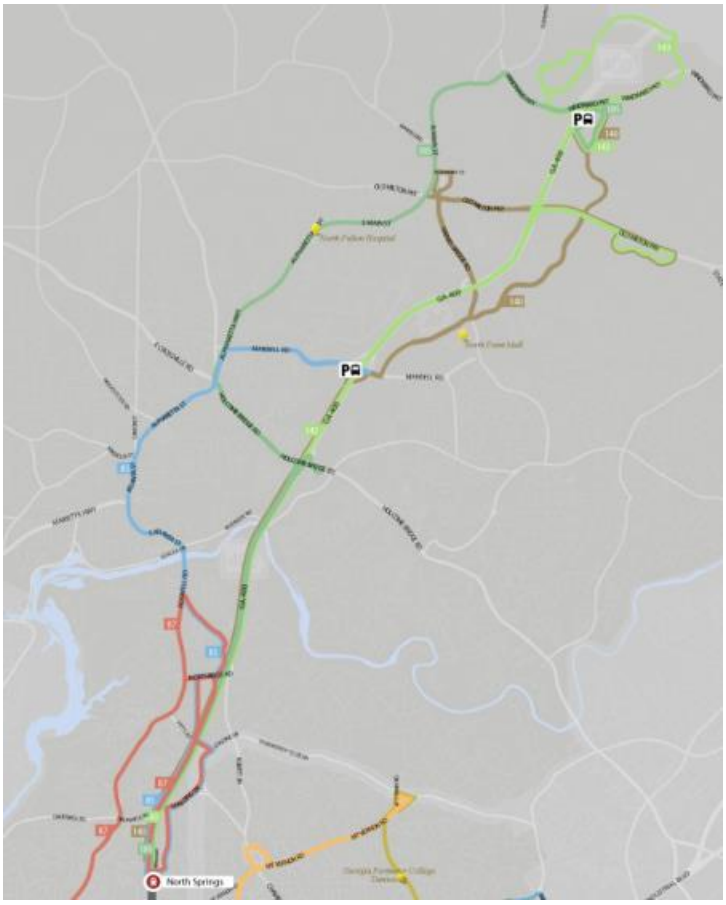

Figure 16: MARTA North Fulton routes serving North Point and Windward Parkway (MARTA, 2015b)

3.1.2 2020 Baseline

This scenario models conditions as they are expected to take place in 2020. The transit files show even more MARTA local bus routes expected to occur in Clayton County. Some important changes were also coded for the CCT system. First, the 10C bus would no longer stop in Marietta; it simply would proceed to Town Center. Second, the model includes a planned circulator bus for the Cumberland area. These changes were already in the model that was provided to the author (S. Lewandowski, personal communication, March 10, 2015). Conditions for other transit largely reflect what is in the 2015 scenario. Minor changes that the author made are listed in Appendix B. We note

that some highway changes are expected to have taken place, namely: (1) new reversible express lanes on the I-75 corridor, both in the northwest and southeast suburbs; (2) I-85 high-occupancy toll (HOT) lane extension to Hamilton Mills (GDOT, 2015a); and (3) reconstruction of the GA-400 and I-285 interchange (GDOT, 2015b). All three projects are in the model as provided to the author. Express buses are modeled to run in the managed lanes when possible.

3.1.3 2020 Stage 1

This scenario combines changes from GRTA's Horizon 1 and MARTA's Phase 1 plan, which resulted from their COA's. The term Stage 1 is introduced to describe these plans collectively. They are expected to be implemented within the next two years (Nelson\Nygaard, 2015f); K. Hayden, personal communication, May 8, 2015). For MARTA's Phase 1 plan, changes are coded for both express and local bus due to their potential interrelation. For the analysis, though, most attention will be focused on express bus. Below, general concepts of Stage 1 for each transit agency are discussed. More details can be found in Appendix B.

GRTA Xpress

GRTA has devised extensive changes for its Horizon 1 plan while keeping its budget constant (Nelson\Nygaard, 2015f). Horizon 1 changes are modeled based on the draft available in early May 2015 (GRTA, mass email, May 1, 2015). A service plan document was later written in August of that year and is available on GRTA's Direct Xpress website (Nelson\Nygaard, 2015f). This plan appears to have changed very little from the May draft. Although the May draft solely influenced the coding of GRTA Xpress changes, the August version is often cited to provide the reader with a document to reference for further information.

The changes with the GRTA Xpress system can be summarized into the following major concepts: (1) intermediate stopping and route consolidation; (2) service to Perimeter Center; and (3) streamlined and consistent routing in the employment center, (4) deletion of reverse commute routes, (5) frequency adjustments based on demand, and (6) connecting with the Gwinnett County Transit (GCT) system (Nelson\Nygaard, 2015f). These concepts are able to be incorporated into the model and are discussed below.

Intermediate Stopping and Route Consolidation

This concept consists of two micro-concepts that are interrelated. For routes from the non-northside suburbs (US-78 East to US-278 West, clockwise), those that are bound for the same center generally would be consolidated into one route, with added frequency. The consolidated routes would make intermediate stops at P&R lots that currently are served by separate routes. For most routes in the sector from US-41 South to US-278 West (clockwise), consolidation also would occur by employment center, such that each route would serve both Downtown and Midtown. As an exception, the routes on the I-75 Southwest corridor are kept separate, both by origin and destination. The two mainline routes on the US-41 South corridor now would serve both Downtown and Midtown (Nelson\Nygaard, 2015f).

The northside routes generally would not be consolidated, with the exception of one route on the I-75 Northwest corridor (GRTA 483). However, with three of them (GRTA 413, GRTA 480, and GRTA 490), an intermediate P&R stop would be added to each one. Additionally, there would be slight frequency reductions.[7] For the I-85

[7] The frequency reductions would take place on the GRTA 413 and GRTA 480. For the GRTA 490, the overall route frequency would stay the same, but fewer runs would go all the way out to Canton. This complexity is simplified in the model as a frequency reduction of one daily trip.

Northeast corridor, a new route is added (GRTA 414) that stops at three P&R lots and subtracts trips from two other routes (GRTA 411 and 412) (Nelson\Nygaard, 2015f).

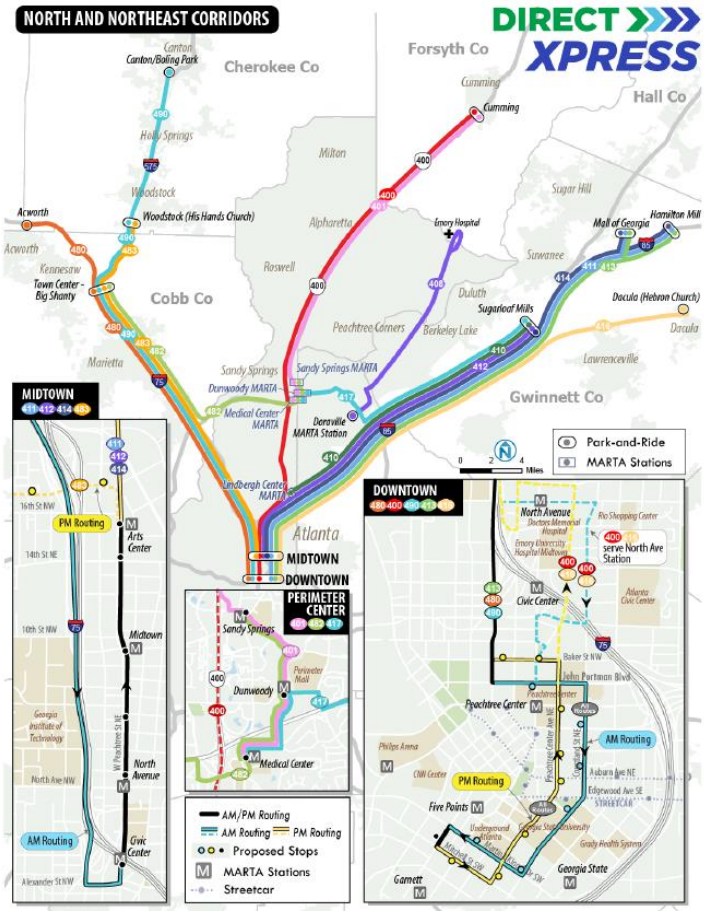

Figure 17: GRTA Horizon 1 plan - Northside routes (Nelson\Nygaard, 2015f)

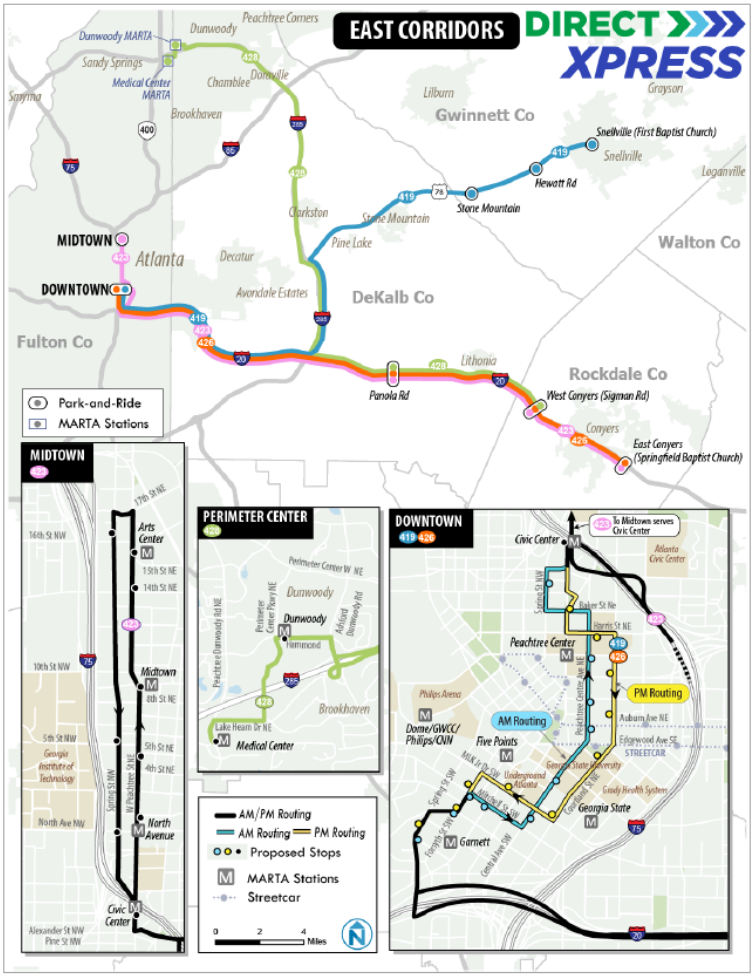

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Figure 18: GRTA Horizon 1 plan - Eastside routes

Service to Perimeter Center

Two new routes would be created that serve Perimeter Center from the northern I-85 and I-75 corridors (GRTA 417 and GRTA 482, respectively). Additionally, a version of the GRTA 400 route, which runs on GA-400, would be rerouted and designated as a new route (GRTA 401). Currently ending at North Springs Station, it now would provide direct service to Perimeter Center. Routes 401 and 482 would stop at all three MARTA stations in the area (Sandy Springs, Dunwoody, and Medical Center), while the 417 would stop just at two of those stations. These three routes would add to the existing GRTA 428 from the I-20 East corridor (Nelson\Nygaard, 2015f).

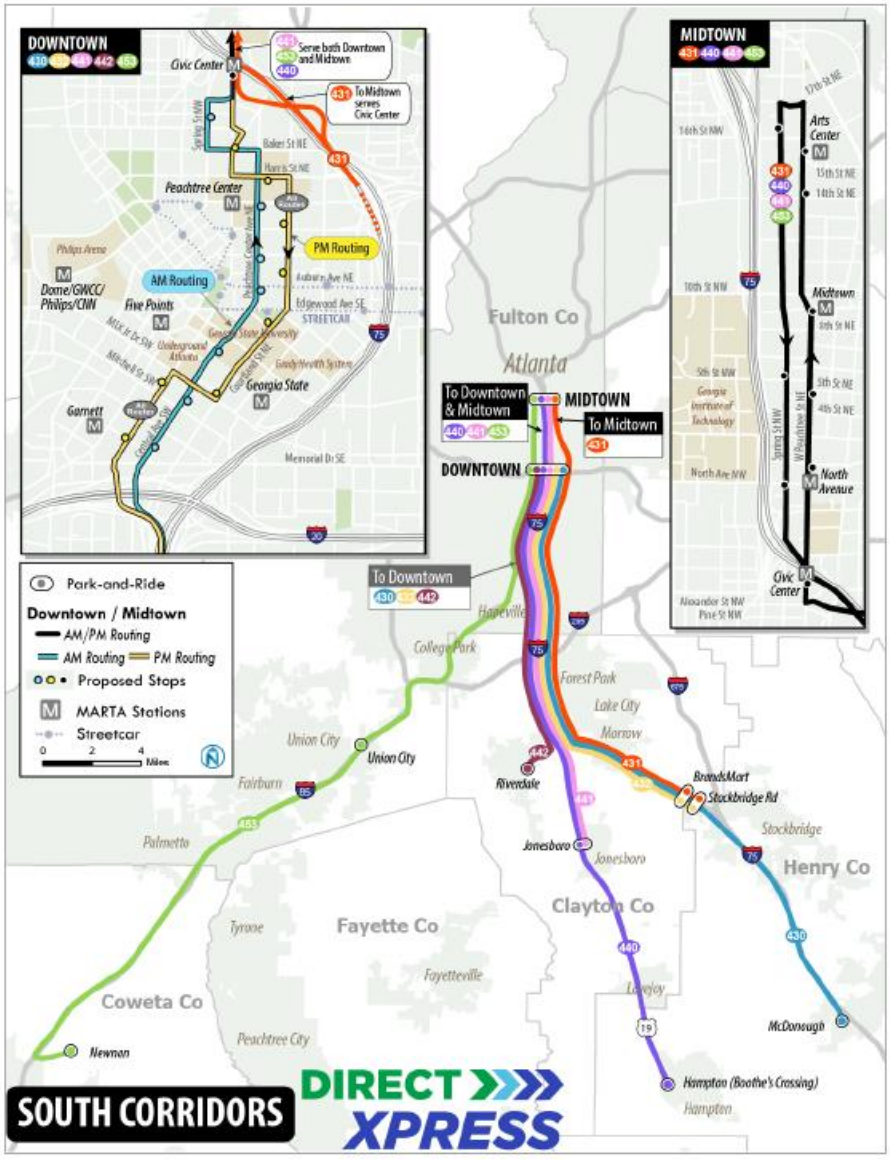

Figure 19: GRTA Horizon 1 Plan - Southside routes (Nelson\Nygaard, 2015f)

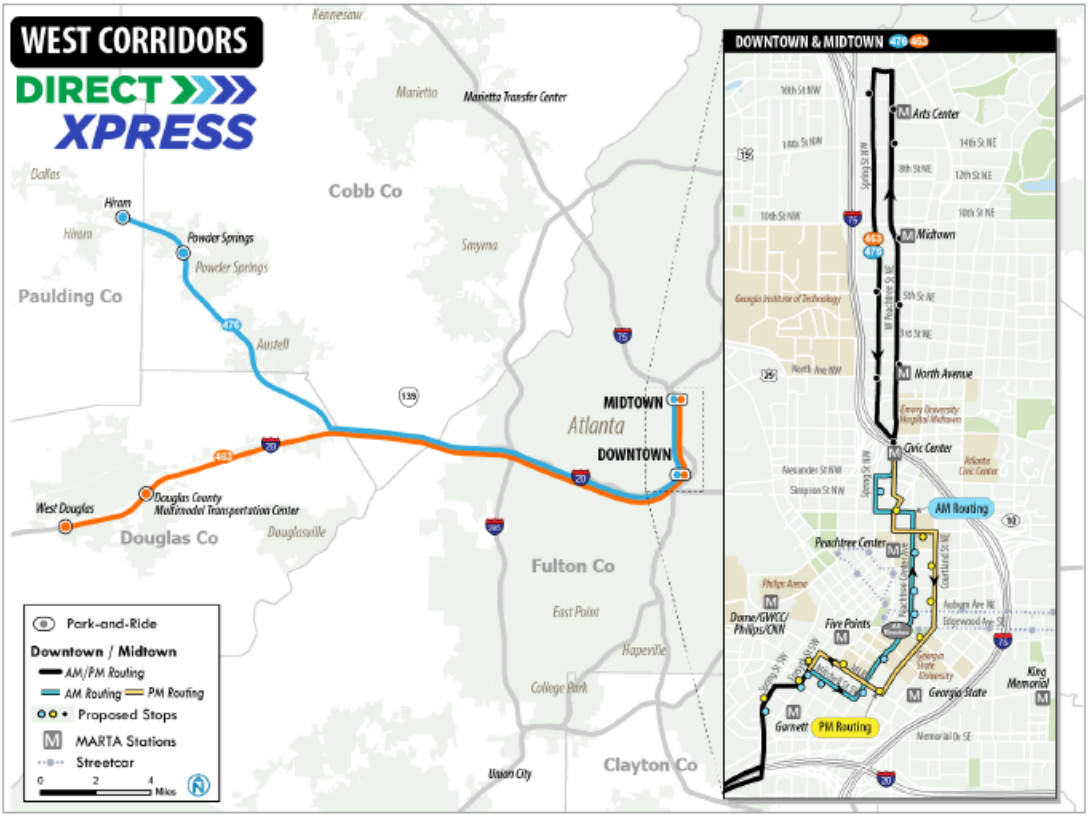

Figure 20: GRTA Horizon 1 Plan - Westside routes (Nelson\Nygaard, 2015f)

Streamlined and Consistent Routing in the Employment Center

Currently, each route to Downtown is unique, relatively speaking, in terms of its routing in the employment center. However, the GRTA Horizon 1 plan would make routing more consistent. Furthermore, the routing would be streamlined. All Downtown-bound routes would travel on the north/south one-way arteries Peachtree Center Avenue and Courtland Street. Routing in the rest of the Downtown varies slightly depending on the bus' originating quadrant in the region (north, south, east, or west). A couple of Downtown-bound routes from the northside also would skirt Midtown along North Avenue, as there would be no separate Midtown-bound route from the same originating P&R lot. The alignments for Midtown-bound routes are largely kept the same, though the consolidated route from the I-75 Northwest corridor (GRTA 483) would change to

mostly conform to the other northside routes. For the one existing route to Perimeter Center (GRTA 428), slight changes are made to streamline the route. The new GRTA 417, also coming from the east, would follow the same routing. Routing changes in the respective employment centers are intended to make service more intuitive and efficient (Nelson\Nygaard, 2015f).

Deletion of Reverse Commute Runs

For many of GRTA's Xpress routes, there is a reverse commute version, in which the main inbound route simply would run from its terminus to its originating P&R lot for the next inbound run. However, there often is not last-mile transit connectivity from these P&R lots (MARTA et al., 2012c), so these runs do not appear to be very useful. GRTA plans to delete all reverse commute runs except for some running on the US-41 corridor (A. Poznanski, personal communication, April 17, 2015) (Nelson\Nygaard, 2015f)[8].

Frequency Adjustments with Demand

Route frequency was adjusted based on demand. For several northside routes, the frequency was reduced. For the southside route from Stockbridge to Downtown (GRTA 432), the frequency is increased (Nelson\Nygaard, 2015f).

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[8] An important note is to be made for the US-41 corridor reverse commute routes. It is clear from GRTA's website that both of the mainline US-41 routes – the 440 and 441 – currently have reverse commute versions (GRTA, n.d.-c). The author interpreted original literature from GRTA (mass email, May 1, 2015) to mean that the 440 reverse commute run would be deleted from Horizon 1. That is, only the 441 would stay, and it would have five daily trips. In the original 2015 and 2020 models, only the 440R is coded in. The author changed it to the 441R and truncated it to end at Jonesboro. In the current Horizon 1 Service Plan, though, which was printed after the routes were coded, it is made more clear that reverse commute versions of both routes would remain. However, there would remain just five total runs between the two routes (Nelson\Nygaard, 2015f). Therefore, the model was not rerun. The conversion from the 440R to the 441R remains a basis for the analysis.

Connecting with the GCT System

For the I-85 NE Xpress buses that serve Sugarloaf Mills, GRTA is having them serve the GCT P&R lot, in addition to the GRTA P&R lot (Nelson\Nygaard, 2015f). The GCT P&R lot is a hub for GCT local buses, so this change would provide greater connectivity with the system (MARTA et al., 2012c).

Non-Modeled Changes

Other changes are planned for Horizon 1 that cannot be taken into account in the model. First, while frequency changes can be taken into account, other scheduling changes cannot. For example, if one of the scheduled departure times is 6:15 AM, and that time is moved 15 minutes later to 6:30 AM, that cannot be taken into account in the model. Second, the model cannot account for certain route complexities, such as providing direct, non-stop service in the morning and combined service in the afternoon. This is the case with routes such as the GRTA 426 (Nelson\Nygaard, 2015f). Thus, judgments were made in coding the routes into the model. For the 426, the route is treated as combined for both morning and afternoon. For the GRTA 490, in which only some runs would serve Canton (Nelson\Nygaard, 2015f), the route is treated as though there is one less daily run.

MARTA

In the MARTA system, there are only planned changes for two of its express routes in Phase 1, both of which provide two-way service to Alpharetta from North Springs Station. With Route 140, which runs to the North Point Mall area, one of its route versions is deleted[9]. There would be slight routing changes with the other version. Route

[9] Really, this route version consists of two route versions – one to the Alpharetta city center and the other to the Georgia State University Alpharetta Center. However, it is modeled as just one version.

143, a peak-hour route to and from the Windward area would be split into three routes – one inbound route and two reverse commute routes. The inbound route would run at high frequency – every 10 minutes. The reverse commute routes would be divided in terms of the part of the Windward area that is served. Each would run at half the frequency of the current 143 route (K. Hayden, personal communication, 2015).

Many local bus changes are planned as well, three of which are highlighted here. First, for several routes, there would be "long" and "short" versions. The short version would be more frequent. Second, some routes would be deleted, including a peak-hour route serving the Cumberland spillover into Fulton County (MARTA 148). Third, Route 1, which may provide last-mile connections from Midtown, would be consolidated and greatly simplified (MARTA, 2015b); K. Hayden, personal communication, 2015).

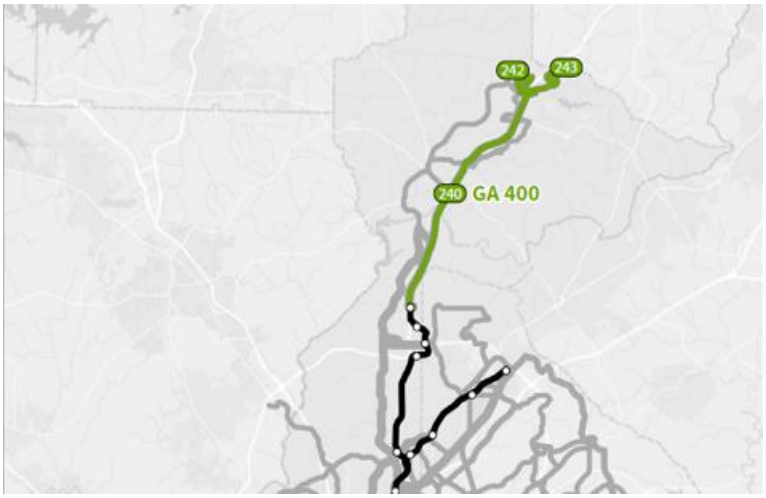

Figure 21: MARTA North Fulton express route plan (K. Hayden, personal communication, May 8, 2015)

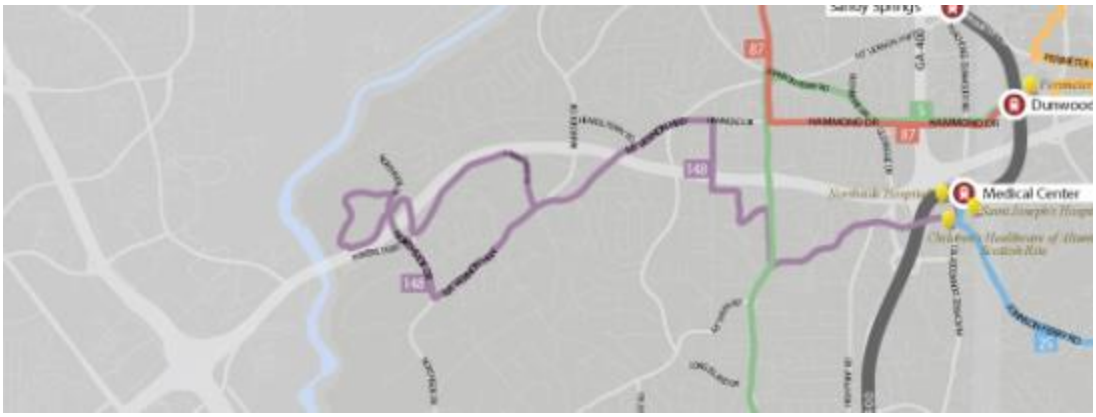

Figure 22: This figure shows MARTA Route 148 (MARTA, 2015b), which is planned to be cut in Phase 1 (K. Hayden, personal communication, May 8, 2015). Notably, the route's western terminus is close to the Cumberland employment center. It may be able to be served by an extension of a peak-hour CCT route.

3.2 Results of the Preliminary Scenarios

In this section of Chapter 3, the results of the preliminary scenarios are discussed. Summary tables for regional measures and transit ridership are presented in this section. The first two regional measures tables show projections both with and without application of the air passenger model. The air passenger model is a component of ARC's trip-based model that predicts the number of air passengers traveling on the ground to and from the airport. Accounting for this is useful in understanding overall tripmaking, though tables showing transit mode split do not account for this model. Thus, results for overall tripmaking are shown with and without application of this model. Tables for regional measures by trip purpose can be found in Appendix C, and boardings by route can be found in Appendix D.

3.2.1 2015 Base to 2020 Base

Between the two baseline scenarios, clear growth is seen for trip making in general, as shown in Table 2 through Table 5. This likely reflects the projected population growth of the Atlanta region, which the model says will go from 5,520,493 to

5,868,766 between the two base years. The transit share for all trips rises by 0.01 percentage points, though interestingly, when divided into trip purpose types, the transit share for each one drops, as seen in Table 25 through Table 30 in Appendix C. Such a phenomenon is possible, as each percentage is based on a different denominator, and this possibility can be proven algebraically. It is an example of Simpson's Paradox, in which aggregate results provide a different picture than disaggregate results (P. Mokhtarian, personal communication, Nov. 29, 2015). The decline is highest for HBW trips, though this trip type still has the largest transit share. Trips are expected to increase on all modes, though percentage-wise, the increase is more dramatic with express bus. Two reasons are likely associated with this change: (1) expected exurban growth; and (2) the presence of new express lanes.

Table 2: Trips 2015 to 2020 Baseline with application of the air passenger model

	2015 Base	**2020 Base**	**Absolute change**	**Percent change**
Transit share	2.13%	2.14%	0.01%	0.47%
Transit trips	378,543	407,444	28,901	7.63%
SOV person trips	10,685,203	11,502,003	816,800	7.64%
HOV person trips	6,676,498	7,096,628	420,130	6.29%
Total trips	17,740,244	19,006,074	1,265,830	7.14%
Regional Congestion Index	1.21	1.26	0.05	4.13%

Table 3: Trips 2015 to 2020 Baseline *without* application of the air passenger model

	2015 Base	**2020 Base**	**Absolute change**	**Percent change**
Transit share	2.00%	2.01%	0.01%	0.50%
Transit trips	351,765	377,195	25,430	7.23%
SOV person trips	10,535,106	11,332,911	797,805	7.57%
HOV person trips	6,676,498	7,096,628	420,130	6.29%
Total trips	17,563,369	18,806,734	1,243,365	7.08%

Table 4: Transit trips by mode 2015 Base to 2020 Base

	2015 Base	2020 Base	Absolute change	Percent change
Local bus	122,650	130,777	8,127	6.63%
Express bus	16,881	20,101	3,220	19.07%
Heavy rail	212,234	226,317	14,083	6.64%
Total	351,765	377,195	25,430	7.23%

Table 5: Transit boardings by mode 2015 Base to 2020 Base

	2015 Base	2020 Base	Absolute change	Percent change
Local bus	263,582	282,580	18,998	7.21%
Express bus	21,604	25,585	3,981	18.43%
Streetcar	186	192	6	3.23%
Heavy rail	283,459	306,534	23,075	8.14%
Total	568,831	614,891	46,060	8.10%

In the 2020 Scenario, new express lanes are planned on the I-85 NE and I-75 NW corridors. The latter project is more substantial, and the model results show the impact of it. Here, several routes on this corridor – CCT 100, CCT 102, GRTA 490, and GRTA 491 – see sharp increases in ridership. Notably, though, the shorter CCT 101 from Marietta sees a sharp ridership drop. This may be due to nearby employment growth, outmigration further into the suburbs, or the increasing attractiveness of longer-distance routes with the express lanes.

Table 6: Select I-75 NW express routes 2015 Base to 2020 Base

Route	2015 Base	2020 Base	Absolute change	Percent change
CCT 100	983	2686	1703	173.25%
CCT 101	298	132	-166	-55.70%
CCT 102	211	445	234	110.90%
GRTA 490	151	340	189	125.17%
GRTA 491	185	393	208	112.43%
CCT 10C	417	196	-221	-53.00%

On the CCT 10C, the reverse commute route to Town Center, ridership is shown to drop dramatically. This is likely due to the deletion of the Marietta intermediate stop.

This stop involves an appreciable deviation, so riders from central Atlanta to Town Center would have a faster ride with it being deleted from the route. However, the benefit is not reflected in the number of boardings. From a ridership standpoint, the Marietta intermediate stop seems worthwhile, though there could be an even greater benefit if handled differently.

Modest changes are seen for the other express bus routes, overall trending positively. Overall growth is by far the highest for several Atlanta-bound buses from Cobb County, as discussed. Growth is also relatively high percentage-wise for routes coming from outer suburbs, such as Cumming, Windward, Hamilton Mills, Dacula, and West Conyers. Relatively high absolute change is seen on the MARTA 140 to the North Point area, the GRTA 432 from Stockbridge to Downtown, and the GRTA 440 from Hampton and Jonesboro to Downtown. GRTA ridership generally seems to be higher in the non-northside suburbs, though the GCT, CCT, and MARTA express buses generally do well. Overall, with a trend toward outward growth and express bus ridership, changes to harness the potential of this mode make sense.

3.2.2 2020 Base to 2020 Stage 1

As a result of the changes of both GRTA and MARTA, a clear positive trend toward transit is shown in terms of transit share, transit trips and transit boardings. From the 2020 Base scenario, the transit share in 2020 Stage 1 increases by 0.01 percentage points without application of the air passenger model and 0.03 percentage points with application of this model. This latter result is interesting, as direct service to the Airport does not change in the Stage 1 scenario. However, the changes appear to benefit Airport travel indirectly. The number of single-occupancy and high-occupancy vehicles (SOV's and HOV's) drops, as desired, though the regional congestion index remains the same. When disaggregated by trip type (HBW, HBO, and NHB), the transit share for each

increases, though interestingly, the increase is greater for non-HBW trips. This may be due to the fact that MARTA local bus changes are incorporated into this scenario as well.

Table 7: Trips 2020 Base to Stage 1 *with* application of the air passenger model

	2020 Base	2020 Stage 1	Absolute change	Percent change
Transit share	2.14%	2.17%	0.03%	1.40%
Transit trips	407,444	411,488	4,044	0.99%
SOV person trips	11,502,003	11,499,395	-2,608	-0.02%
HOV person trips	7,096,628	7,094,931	-1,697	-0.02%
Total trips	19,006,074	19,005,815	-259	0.00%
Regional Congestion Index	1.26	1.26	0.00	0.00%

Table 8: Trips 2020 Base to Stage 1 *without* application of the air passenger model

	2020 Base	2020 Stage 1	Absolute change	Percent change
Transit share	2.01%	2.02%	0.01%	0.50%
Transit trips	377,195	380,596	3,401	0.90%
SOV person trips	11,332,911	11,331,058	-1,853	-0.02%
HOV person trips	7,096,628	7,094,931	-1,697	-0.02%
Total trips	18,806,734	18,806,586	-148	0.00%

Disaggregated by transit mode, the number of trips increases for express bus and local bus. The absolute change for these two modes is about the same, though the percent change for express bus is dramatically higher. In terms of boardings, the local bus sees the highest absolute change while express bus sees the highest percent change. Each of these changes exceeds those of other modes by far. The number of local bus boardings far exceeds local bus trips, which suggests that more people may use local bus for first and

last mile connectivity when traveling on premium transit modes. Heavy rail ridership drops by nearly 3%, both in terms of trips and boardings. Although the percent is small, this translates into over 6,500 trips and nearly 9,000 boardings. The decline may result from express bus improvements, as riders may no longer feel the need to drive to the terminating rail station. Furthermore, with direct service to Perimeter Center, riders bound for there would not need to transfer at North Springs Station or some other MARTA station. Overall, the Stage 1 changes result in a gain of over 3,000 transit trips and nearly 10,000 transit boardings.

Table 9: Transit trips by mode, 2020 Base to Stage 1

	2020 Base	2020 Stage 1	Absolute change	Percent change
Local bus	130,777	135,692	4,915	3.76%
Express bus	20,101	25,110	5,009	24.92%
Heavy rail	226,317	219,794	-6,523	-2.88%
Total	377,195	380,596	3,401	0.90%

Table 10: Transit boardings by mode, 2020 Base to Stage 1

	2020 Base	2020 Stage 1	Absolute change	Percent change
Local bus	282,580	296,245	13,665	4.84%
Express bus	25,585	30,542	4,957	19.37%
Streetcar	192	171	-21	-10.94%
Heavy rail	306,534	297,772	-8,762	-2.86%
Total	614,891	624,730	9,839	1.60%

At the route level, express bus is the focus of the analysis, even though local bus changes were coded into the model as well. Local bus results can be found in Appendix D. For GRTA routes that were combined, resulting in intermediate stops but increased frequency per user, ridership rose dramatically. The best example of this is the GRTA 426 on the I-20 East corridor, in which the results suggest that overcrowding may become a problem. GRTA has shown agreement with its potential overcrowding in its

Horizon 1 plan, which is why nonstop service is planned for the morning (Nelson\Nygaard, 2015f). The benefit of reducing wait time outweighs that of increasing in-vehicle travel time (IVTT) for intermediate stops.

Table 11: GRTA Xpress routes that are combined in Stage 1 (Horizon 1)

Base Route	Stage 1 Route	2020 Base	2020 Stage 1	Absolute change	Percent change
GRTA 418 GRTA 424	GRTA 419	542	749	207	38.19%
GRTA 421 GRTA 423	GRTA 423	482	1062	580	120.33%
GRTA 420 GRTA 422 GRTA 425	GRTA 426	1804	4421	2617	145.07%
GRTA 450 GRTA 451 GRTA 455	GRTA 453	555	920	365	65.77%
GRTA 460 GRTA 461 GRTA 462	GRTA 463	1882	2265	383	20.35%
GRTA 470 GRTA 477 GRTA 475	GRTA 476	1430	1763	333	23.29%
GRTA 481 GRTA 491	GRTA 483	394	724	209	112.97%

For routes in which intermediate stops were added, but frequency *decreased*, ridership fell, even when measured by run. The decline makes little difference per run for the 413, yet it makes a dramatic difference for the 480 and 490[10]. The latter two are both Downtown-bound routes in which an intermediate stop is added in Town Center, which

[10] The frequency on the 490 itself does not change, but not all runs will extend to Canton (Nelson\Nygaard, 2015f). Thus, the overall route was coded to have one less daily run.

could be thought to compete with the CCT 100. Interestingly, though, ridership increases on the CCT 100 increases by nearly 200 boardings, despite the fact that no changes were made to it. Perhaps riders are drawn to the overall increased frequency from Town Center, and some may be former 480 and 490 riders that are now choosing to drive to Town Center. There is also the possibility that the CCT coverage in Downtown is more attractive to these riders than the new proposed GRTA coverage.

Table 12: GRTA Xpress routes with frequency reductions – total boardings

Route	**Intermediate stop added?**	**2020 Base**	**2020 Stage 1**	**Absolute change**	**Percent change**
GRTA 413	Yes	186	145	-41	-22.04%
GRTA 480	Yes	186	38	-148	-79.57%
GRTA 490	Yes	340	72	-268	-78.82%
GRTA 408 Outbound	No	287	131	-156	-54.36%
GRTA 410	No	15	0	-15	-100.00%
GRTA 442	No	121	89	-32	-26.45%

Table 13: GRTA Xpress routes with frequency reductions - boardings per run

Route	**Intermediate stop?**	**2020 Base**	**2020 Stage 1**	**Absolute change**	**Percent change**
GRTA 413	Yes	14	13	-1	-7.14%
GRTA 480	Yes	17	4	-13	-76.47%
GRTA 490	Yes	43	10	-33	-76.74%
GRTA 408 Outbound	No	36	22	-14	-38.89%
GRTA 410	No	2	0	-2	-100.00%
GRTA 442	No	10	9	-1	-10.00%

For routes in which frequency was merely reduced, ridership dropped, as expected. For the 442, the boardings per run stayed about the same, whereas for the 408, the boardings per run dropped noticeably. For the 410, running on I-85 NE to Lindbergh,

ridership dropped to 0, which could be due both to frequency reductions and the provision of service to Perimeter Center.

For the GRTA 401, which was renamed in the model from the GRTA 400A, ridership increased almost threefold. Providing direct service to Perimeter Center, as opposed to North Springs Station, shows to be a positive move, despite the reduction in frequency. For the two new routes to Perimeter Center – the GRTA 417 from I-85 NE and the GRTA 482 from I-75 NW – ridership is low on the first and modest on the second. The ridership of the existing GRTA 428 increased twofold, despite the fact that frequency did not change. This may be due to the greater access to the route from East Conyers, using the GRTA 423 and 426. Furthermore, the streamlining of the route in Perimeter Center may have had a positive effect as well, as riders now can access the route's two MARTA stations in less time.

Table 14: GRTA Xpress Perimeter Center routes - total boardings

Route	**Corridor**	**2020 Base**	**2020 Stage 1**
GRTA 401	GA-400 N	31	92
GRTA 417	I-85 NE		16
GRTA 428	I-20 E	15	31
GRTA 482	I-75 NW		110

With streamlined routing in Downtown, the results are inconclusive. It often was coupled with other route changes, such as combining with other routes. Ridership on Downtown-bound routes often increased. For the standalone GRTA 400 to Downtown, which was slightly truncated, ridership decreased by one third, or 14 boardings. For the GRTA 416 (Dacula to Downtown), which was rerouted to skirt Midtown on North Avenue, ridership increased by 14%, or 37 riders. On the GRTA 432, running nonstop from Stockbridge to Downtown, ridership fell by 3%, or 59 riders, despite an increase in frequency. The decline could be due to the reduction in coverage Downtown, which

affects southside routes the most. Routes from the southside would no longer stop directly at the Federal Center[11], which is a controversial decision (GRTA, mass email, May 20, 2015). The results give some suggestion that streamlined routing could deter ridership, but the deterrence appears too small to be important. Furthermore, the potential of streamlined routing to attract new riders, due to ease of understanding, may not be taken into account in the model. Overall, streamlined routing seems advantageous for GRTA and other express bus agencies to pursue.

An interesting result is seen for the GRTA 411-412-414 triplet, consisting of the new 414 sweeper route that combines the 411 and 412. Aggregate ridership increases from the 411-412 double in 2020 Baseline. However, when reviewing disaggregate ridership, it appears that the increase happened almost exclusively on the 412. The small ridership projection on the 414 is less than the loss of riders from the 411.

Table 15: GRTA Xpress I-85 NE routes to Midtown

Routes	**Origins**	**2020 Base**	**2020 Stage 1**	**Absolute change**	**Percent change**
Aggregate					
GRTA 411 GRTA 412 GRTA 414	Hamilton Mills Mall of Georgia Sugarloaf Mills	318	420	102	32.08%
Disaggregate					
GRTA 411	Hamilton Mills Mall of Georgia	230	165	-65	-28.26%
GRTA 412	Sugarloaf Mills	88	195	107	121.59%
GRTA 414 (New)	Hamilton Mills Mall of Georgia Sugarloaf Mills		60		

[11] "Federal Center" is used in this thesis to refer to three Federal buildings within close proximity of each other in Downtown.

For the remaining reverse commute version of an Atlanta-bound route, the GRTA 440R becoming the GRTA 441R[12], ridership increases by 50%. Perhaps there is a stronger market to the US-41 corridor from Midtown than Downtown. There is also the possible effect of deleting the GRTA 442R.

On the MARTA system, the ridership on the 140 dropped, as expected, due to cutting a version of the route (but keeping the other version's frequency the same). However, the number of boardings per run increased significantly. With the 143 being split into three routes, the overall ridership increases, though the boardings per run drops by 2. The inbound MARTA 240 dramatically outperforms the reverse commute 242 and 243, which run at one-third of the frequency.

Table 16: MARTA GA-400 express routes boardings

Base Routes	**Stage 1 Routes**	**2020 Base**	**2020 Stage 1**	**Absolute change**	**Percent change**
MARTA 140A A MARTA 140W A	MARTA 140W A	1287	1022	-265	-20.59%
MARTA 140A B MARTA 140W B	MARTA 140W B	1002	961	-41	-4.09%
MARTA 143	MARTA 240 MARTA 242 MARTA 243	1426	1621	195	13.67%

For express buses from other agencies, both with reverse commute and inbound routes, little change takes place, except for the CCT 100 as mentioned earlier.

[12] The author later discovered that this "conversion" is not quite true, but it still remains a basis of the analysis. Please see earlier footnote in this chapter for a more detailed discussion.

Interestingly, with the GCT 101 from the Mall of Georgia, ridership would increase slightly, despite now competing with the GRTA 413.

In the scenario combining GRTA's Horizon 1 and MARTA's Phase 1 plans, transit ridership increases, especially for express bus. We make note of successful strategies for implementation in the Experimental Scenario.

3.3 Conclusions from the Preliminary Scenarios

From 2015 to 2020, we see "automatic" growth in both transit ridership and traffic volumes as the region adds population. In 2020, from the Base to Stage 1 scenarios, ridership increases are seen overall, especially express bus. Frequency appears to be a very strong driver of ridership. Adding both frequency and intermediate stops yields overwhelming ridership increases, despite the longer travel time for some riders. Deleting intermediate stops, as seen with the CCT 10C, appears to decrease ridership. The disparity in northside ridership from the rest of the metro suggests the importance of serving suburban employment. Notably, the model has a "gravity" assumption (ARC, 2011), in that trips are more likely to be distributed to jobs that are closer to home. It may thus underestimate the amount of long-distance travel from the northside suburbs to central Atlanta. Nonetheless, the preliminary scenarios justify a service strategy of intermediate stopping on existing routes and adding frequency. This strategy will be explored in the Experimental Scenario.

CHAPTER 4

EXPERIMENTAL SCENARIO DESIGN

In Chapter 3, when the three preliminary scenarios were tested, growth trends and the effectiveness of different service strategies were observed. In this scenario, that insight is applied to investigate potential changes that would allow express bus to provide even better polycentric connectivity. This chapter discusses service strategies and then identifies centers to which to apply these strategies. Detailed route-by-route changes can be found in Appendix E. This chapter discusses proposed changes from a big-picture perspective.

4.1 Service Strategies

Service strategies to be tested with our 2020 Experimental Scenario are outlined in this section. These strategies would provide a means of serving dispersed, polycentric travel demand in a relatively efficient manner. Service strategies are grouped into seven "macro strategies," from which smaller "micro-strategies" follow

Macro Strategy 1: Intermediate Stopping

This is the most important strategy of this paper, as it shows that suburban employment markets can be served on routes that are already existing or planned. For example, GRTA identified markets to the North Point and Cumberland employment centers from Cumming and I-75 NW P&R lots, respectively (Nelson\Nygaard, 2015c). These centers are bypassed by existing routes from these origins. An intermediate stopping service strategy can allow GRTA to serve these markets without needing new routes. Furthermore, to serve employment on the GA-400 and I-75 NW corridors, MARTA and CCT, respectively, operate several freeway bus routes – at least one per center (MARTA et al., 2012c). An intermediate stop strategy would allow routes to be

consolidated with added frequency. The importance of frequency is not to be understated, as out-of-vehicle travel time (OVTT) deters ridership more heavily than in-vehicle travel time (IVTT) (ARC, 2011). Especially in the sprawled Atlanta region, limited resources may be better spent on one high-frequency line with intermediate stops than several low-frequency non-stop routes. Intermediate stops are the norm on train lines. It is more challenging to implement with express bus, though, for a number of reasons. It is important that longer-distance riders are not significantly affected adversely with the addition of intermediate stops. Discussed here are a variety of micro strategies to allow a good outcome for all riders.

Micro strategy 1-1: Determine the Form of Intermediate Stopping

More than one form of intermediate stopping can take place, and choosing a good form depends on contextual factors. Three forms are explored in this thesis.

Form 1: Directly Stopping at an Existing Hub

A P&R lot is considered a hub, as it is a collection point for travelers from a variety of origins. An express bus can stop directly at the P&R lot, which would be convenient and comfortable for those traveling from the lot. Riders to and from intermediate stops would not need to transfer. GRTA is implementing this strategy with many of its routes in its Horizon 1 plan (Nelson\Nygaard, 2015f). However, it would involve deviations for those traveling from a longer distance. This can result in a significant amount of added travel time (Brown & Thompson, 2009a) and have a strong negative perception. GRTA has received much criticism from existing riders for its plans to add intermediate stops (Public meeting, May 6, 2015). Express buses may struggle to attract riders with too many deviations.

Despite the deviations, though, the model generally supports this form of stopping, based on comparing results from Stage 1 and 2020 Base. Adding frequency to

compensate for a longer bus ride increases ridership significantly, both per run and overall, as explained above. This is because OVTT is reduced, and more potential riders are served.

What needs to be taken into account, though, is the travel time involved deviating to get to and from the intermediate hub. If the hub is very close to the freeway exit, then express bus may wish to serve it directly, as the added IVTT may be less than the 10-minute transfer penalty involved if a rider needs to take a local bus from the hub to the express bus. Other factors are the presence of a local transit system in the hub area, the expected demand, if there would be local stops on the way to the hub, and whether the hub is in a production or attraction center. In a trip attraction center, riders would need transit to disperse to their final destinations. Depending on the context, the freeway interchange may be a better dispersion point than a remote hub, as later discussed.

In the Experimental Scenario, this form of intermediate stopping is applied to P&R lots that are close to the freeway, such as Indian Trail along I-85 NE. Stage 1 routes with intermediate stopping are kept in their planned form. For other forms of intermediate stopping, this thesis focuses on employment centers and new stops.

Form 2: Stopping on the Freeway Interchange

This form involves the least amount of deviation for express bus, and it would be good in contexts that require last-mile transit connectivity in different parts of the center. However, this form may be controversial, as freeway interchanges tend to be car-oriented and could be dangerous to pedestrians boarding or alighting a transit vehicle. Minor construction would be needed for the safety and comfort of these passengers, such as crosswalks, streetscape buffers, and bus shelters. Additional minor construction would be needed for the bus to stop on the ramp and to allow the bus to proceed directly from the off-ramp to the on-ramp. Although this construction would involve money and time, the expense appears to be well below that of a brand new transit right-of-way! Not all

interchanges would be candidates for this form of stopping. Targets would be diamond interchanges, in which the bus would exit the freeway, stop where the off-ramp meets the local road, drop off and pick up passengers, and then cross the local road to the on-ramp to get back on the freeway. Practically, this would turn express bus into a makeshift form of freeway bus rapid transit (BRT), using the facilities that are already present. Put another way, this would make express bus behave like a train.

Local bus connectivity may be necessary for this form of stopping. Passengers would leave the express bus and board a local bus to connect them to their final destination, or they would leave a local bus to board the express bus. Ideally, several local buses should be connecting passengers to several parts of the area. This form of stopping is less ideal in contexts such that all passengers take the same shuttle bus and are traveling to and from the same hub location. If the hub is close to the freeway, then it may be better for the bus to make a small deviation to that hub to avoid the transfer penalty, following Form 1.

In the Experimental Scenario, this form of stopping is applied in several employment centers, including Druid Hills, Cumberland, and Fulton Industrial. It is not often applied in origin centers (P&R lots), unless it is also an employment center (as is the case with Windward). Intermediate freeway ramp stops on existing routes may work well in areas that otherwise would be considered too unimportant for express bus to serve, such as the Northlake Mall area.

Form 3: Streamlined Routing Through the Center

Sometimes in a center, freeway interchanges may not be well designed for direct stopping on the ramp. However, the local roadway network allows for the express bus to deviate slightly from the freeway, briefly run on a road parallel to the freeway, and then

reenter the freeway. Examples pertinent to this thesis are Perimeter Center[13] and Doraville. For both centers, the routes would run by MARTA rail stations, which are hubs, so this form can be perceived as a version of Form 1.

Micro strategy 1-2: Differentiate Levels of Express

Even if intermediate stopping happens as prescribed in Form 2, with practically no deviation from the freeway, this strategy can be inhibited by congestion. This is true especially on the I-85 NE corridor, which has left-side HOT lanes without its own exits (as seen in model provided to the author). The ability of express bus to use the lanes is desired. With too many intermediate stops, though, the bus would need to cut across several lanes of congestion several times, imposing a significant burden to longer-distance riders and undermining the purpose of the HOT lanes. Furthermore, if too many express buses are stopping at the same intermediate stop, bus bunching could occur, and providing local bus connectivity with matching frequency could be cost prohibitive. Thus, on some corridors, differentiating levels of express service is necessary. This technique is similar to a service strategy on subway lines in Manhattan (Metropolitan Transportation Authority, 2015a). Some routes would remain nonstop or make fewer stops than its counterparts on the same corridor.

Micro strategy 1-3: Consolidate Routes

When intermediate stops are added to a route, then shorter routes can be eliminated or repurposed, and the longer route can have more frequency. In the Experimental Scenario, this would be the case with both origin and destination centers,

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[13] As later discussed in this chapter, routing in Perimeter Center for GA-400 routes would be more streamlined than GRTA's Horizon 1 plan for its Route 401. The routing would also allow its Route 400 to stop in Perimeter Center and then continue to Downtown Atlanta. A local circulator bus would provide last-mile connectivity.

such as Indian Trail, Marietta, Riverdale, Mableton, Cumberland, and North Point. The Indian Trail P&R lot can be served directly, while the other three need local buses to connect them with mainline express buses. The connecting local buses can be more frequent than current nonstop express routes due to the shorter length requirements, and mainline express routes can be more frequent due to both intermediate stops and anticipation of more riders.

Micro strategy 1-4: Compensate with Frequency

Because the intermediate stopping service strategy involves longer IVTT for passengers and transferring, the inconvenience should be compensated with frequency. Otherwise, public perception may be a significant barrier to implementing the plan. Furthermore, added frequency takes into account the potential uptick of riders from improving access. In the Experimental Scenario, one to two runs per direction are added for each intermediate stop, depending on whether the bus stops on the freeway interchange or deviates from the freeway. Some connecting local buses would have frequencies adjusted to be in line with express buses.

Macro Strategy 2: Enhanced Connectivity within the Center

Currently, within an employment center, express bus attempts to cover as much area as possible, such that it can provide a one-seat ride to all customers. GRTA, appearing to realize the drawbacks of this strategy, is streamlining routes within the centers. The streamlining is intended to save costs and provide people with a more intuitive understanding of the system (Nelson\Nygaard, 2015f). CCT and GCT should arguably do the same with its Downtown-bound express buses. However, as seen with complaints about cutting direct service to the Federal Center for southside riders (GRTA, mass email, May 20, 2015), Horizon 1 appears to lack a plan for local bus connectivity. Lacking such connectivity may suffice in walkable urban environments such as

Downtown, but in car-oriented suburban employment centers, last-mile transit connections may be more important.

The role of local transit is easy to overlook. It can be illustrated with the dynamics of New York City. One commuter system that feeds into New York, New Jersey Transit (NJT), is the third largest commuter rail system in the United States (APTA, 2013). Overwhelming demand exists on lines going into New York, such that construction began on a second river tunnel. The scale of the project was comparable to the Boston Big Dig (Frassinelli, 2010). Yet, all NJT lines going into New York stop at just one point in the city – at New York Penn Station (NJ Transit, 2014). Not everyone on those trains is traveling to the Penn Station area, yet that station has good connections to subway and local bus (Metropolitan Transportation Authority, 2015a) (Metropolitan Transportation Authority, 2015b). Even though riders need to transfer, the route structure is efficient and intuitive. It reflects the "collect and disperse" nature of travel demand. Thus, it attracts high ridership. Commuters from New Jersey to New York may simply say that they take NJT to the city, yet local transit is important to the success of NJT.

Providing local bus connections, though, do not seem to take priority with express bus agencies in Atlanta. Brown and Thompson note that GRTA perceives transfers to be a "bad thing" (Brown & Thompson, 2009b, p. 108). It may believe that choice riders are not inclined to transfer. This belief is reflected in ARC's model, as it differentiates the transfer penalty between drive-to-transit and walk-to-transit riders (ARC, 2011). NJT commuters to NYC, though, are largely "choice riders," as evidenced by station parking fees and high train fares (NJ Transit, 2015a, 2015b). Transfers can be undesirable and add a significant amount of travel time. They also can be disruptive to riders who wish to do work (P. Mokhtarian, personal communication, 2014) or sleep while riding. However, the literature points out the necessity of transfers for a transit system to achieve its full potential (Cervero, 1986) (Brown & Thompson, 2009b). Strategies exist to mitigate the

undesirable nature of transfers, including timed transfers (Cervero, 1986). When properly managed, transfers can benefit rather than hurt transit.

Local transit connections are especially important in employment centers that are intermediate stops, as express bus needs to minimize time spent in the center. Local bus can also help to streamline passenger trips, as several local buses can provide passengers with direct connections to their final destinations. This "hub and spokes" approach may be preferred over waiting on a single zigzagging express bus. Local bus connections can serve to maximize coverage while minimizing travel time.

In the Experimental Scenario, modifications are made to local bus routes in several centers to connect them with express bus. Some routes were streamlined or extended. In some centers, such as Perimeter Center, Airport, Cumberland, and Sugarloaf Mills, new peak-hour circulator or local routes are proposed. Sometimes, several express bus routes were repurposed such that only one route remained express, while the other routes were truncated just to be local routes providing last-mile connectivity. This was the case in North Point / Windward, Cumberland, and Marietta. Frequency was added to all such local and express routes. By integrating local transit, riders can have frequent and intuitive service to their destinations.

Macro Strategy 3: Connections to Other Regional Transit

Not only should express buses be integrated with local buses, but they should also be better integrated with the MARTA rail and other express bus routes. In the Stage 1 plan, rail line termini are generally bypassed by express bus (Nelson\Nygaard, 2015f). Connecting with the MARTA system can serve dispersed demand at a variety of destinations. In this thesis, intermediate stops are proposed near termini stations. Routes to Perimeter Center from the northeast quadrant of the region would stop at Doraville Station. Some routes to and from Atlanta on I-85 NE would stop on Chamblee-Tucker Rd, which has local bus connections to Chamblee Station (MARTA, n.d.-a). On the east

part of I-285, the GRTA 428 and GRTA 419 would stop at Memorial Drive, which has local bus connections to Kensington Station (MARTA, n.d.-a). All buses from the southside would stop in the Airport area. Finally, buses from I-20 West and US-278 West would stop at Fulton Industrial, where the CCT 30 would connect riders to and from Hamilton E. Holmes (HE Holmes) Station (CCT, n.d.-b).

In addition to the MARTA rail system, express buses can also connect with other express buses. The Experimental Scenario has several express bus hubs where this can take place, such as Perimeter Center, Doraville, and Fulton Industrial.

Macro Strategy 4: Route Extensions

The routing of express buses is radial, as they mostly begin in an outer suburb and end in the central city. The MARTA heavy rail system, in contrast, is diametrical, as lines extend beyond Downtown to outlying termini (MARTA et al., 2012c). Diametrical routing may be effective at serving both suburb-to-suburb commutes that pass through Atlanta and reverse commutes. To constrain the scope of the thesis, though, diametrical routing of express buses through central Atlanta is not studied here, as reverse commute routes exist. However, route extensions are studied for Stage 1 routes bound to two outlying centers: Perimeter Center and Lindbergh Center. These extensions would provide diametrical routing, or in this case, V-shaped routing. Such routes from I-75 NW would continue onto I-85 NE, and vice versa. End points would be Sugarloaf Mills and Town Center, respectively.

Perimeter Center, particularly Medical Center Station, would serve as a hub point for crosstown commuting. Express bus riders from other corridors could transfer at Perimeter Center to access employment on the I-75 NW, GA-400, or I-85 NE corridors.

Lindbergh Center would serve as a reverse commute hub point. Currently, no express bus P&R lot exists in the City of Atlanta (MARTA et al., 2012c) (MARTA, GCT, CCT, GRTA, & ARC, 2012b) (MARTA, 2014b) (Google, 2015b). Yet, much of

the city is car dependent. Lindbergh Center Station could be a P&R lot for reverse commute express buses. The GRTA 410 can be extended to serve the reverse commute on the I-75 NW corridor, and the GCT 103A for I-85 NE can be routed to stop at Lindbergh Center.

Macro Strategy 5: Attention to the Reverse Commute

The reverse commute market is important to serve, as it appears to be growing (Hartshorn, 2009), and those living in the city of Atlanta may be especially inclined to take transit if given the opportunity. This Experimental Scenario gives cursory attention to this issue, and further research is recommended. Nonetheless, two micro strategies are tested: (1) treating Lindbergh Center Station as a P&R hub point, as discussed in Macro Strategy 4, and (2) making slight but parallel freeway deviations to make local stops. Such local stops are made in two areas: (a) near Lindbergh Center Station, including along Monroe and Armour Drives, and (b) in Atlantic Station and along Northside Drive. Such stops can be justified with the OnTheMap tool showing relatively high population in the corresponding nearby census tracts (U.S. Census Bureau, 2011).

Macro Strategy 6: New and Repurposed Express Routes

One new express bus route is proposed in this thesis, and two less productive routes are repurposed and rerouted to serve new markets. In the Experimental Scenario, old routes that are repurposed include:

- GCT 102 – repurposed as a local two-way route connecting Indian Trail to Peachtree Corners.
- GRTA 475 – currently a low-ridership route from Mableton to Downtown, GRTA plans to discontinue this route in Horizon 1 (Nelson\Nygaard, 2015f). However, this thesis proposes to repurpose the route as serving the identified Mableton to Perimeter Center market (Nelson\Nygaard, 2015c) via Fulton Industrial. This

would provide several connections, including to the GRTA 463 and 476 to central Atlanta and the CCT 30 to the Blue Line or Six Flags.

- GRTA 500 – the only new express route proposed in this thesis, serving the GRTA-identified demand to Perimeter Center from the US-78 E corridor (Nelson\Nygaard, 2015f). The name GRTA 500 is a placeholder and can be changed if implemented.

Macro Strategy 7: Connectivity between Transit Agencies

Brown and Thompson in particular address the need for greater collaboration between transit agencies in the Atlanta region (Brown & Thompson, 2009b). In this thesis, all express buses between different agencies are coordinated as one system. CCT and GCT express routes would have the same routing in Downtown and Midtown as in GRTA's Horizon 1 plan. CCT and GRTA routes serving outbound commutes to Town Center would have the same routing, and inbound GRTA and MARTA express routes would have the same routing in Perimeter Center. Prior macro strategies in this thesis also seek to enhance coordination between transit agencies.

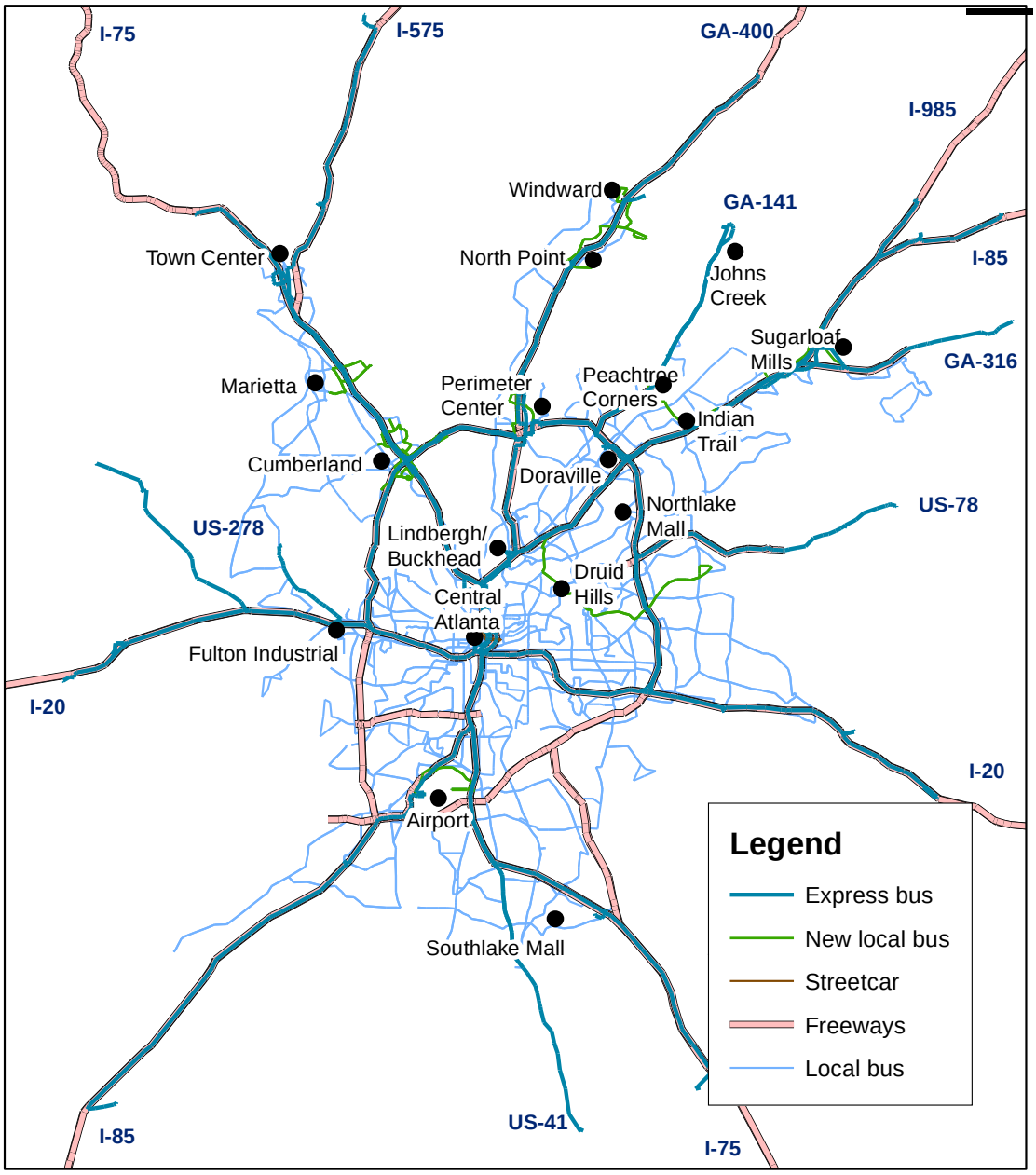

Figure 23: Employment Center Map

4.2 Identified Centers

In designing this scenario, outlying employment centers are identified to which to improve transit service. Identification of such centers comes from GRTA literature, existing and planned transit routing, OnTheMap from the US Census Bureau, other literature, and Google Maps aerial imagery. The centers to which to provide greater express bus service are discussed below.

North Point and Windward

North Point and Windward, both of which are in Alpharetta along GA-400, are listed as two separate centers in ARC's regional center list (ARC, 2015). However, they are adjacent to each other. GRTA only considers North Point in its market analysis (Nelson\Nygaard, 2015c), but MARTA's plans (K. Hayden, personal communication, 2015) and other sources consistently highlight the importance of Windward. GRTA's market analysis shows demand to North Point from both Cumming and Central Atlanta (Nelson\Nygaard, 2015c).

The market from Cumming is not served, though this can change with intermediate stopping on GRTA's 400 route (MARTA et al., 2012c). The route would stop at Windward Parkway and Mansell Road. Because there are P&R lots in these two areas (MARTA, 2015b), these intermediate stops would serve both those who live and those who work in the area. The route would stop directly at the Mansell P&R lot directly due to being nested in the freeway interchange (Google, 2015k). The Windward stop, in contrast, would simply be on the interchange. Riders can access the route from the P&R lot via a local MARTA bus. The parallel GRTA route 401 would be kept as nonstop and bypass these stops.

MARTA currently serves the reverse commute market to these centers, though with separate, lower-frequency bus routes and with a technology-required transfer at North Spring Station (MARTA, n.d.-a). That is, riders from central Atlanta would take

the Red heavy rail line to its North Springs terminus, where they would transfer to express buses. Separate buses go to North Point and Windward. These routes can be consolidated onto a high-frequency trunk route with high-frequency connecting local bus routes. The MARTA 140 and 242 can simply be local circulator routes during the peak hour, with the 242 serving areas where service is planned to be cut in Phase 1.

Perimeter Center

GRTA identified markets to this center from all over the northern suburbs (Nelson\Nygaard, 2015c). Its Horizon 1 plan provides new service to Perimeter Center from northside suburbs (Nelson\Nygaard, 2015f). This service can be enhanced and expanded.

The market from Mableton, along the US-278 W corridor (GRTA, n.d.-c), would be served by reviving and rerouting the GRTA 475, which GRTA plans to discontinue in Horizon 1 (Nelson\Nygaard, 2015f). The routing would go through Fulton Industrial, allowing Downtown riders to transfer to another express bus, and then continue to Perimeter Center. The route would also serve riders from Douglasville on the I-20 West corridor.

The market from Hewatt Rd, along the US-78 E corridor (GRTA, n.d.-c), would be served with a new route, which this author calls the GRTA 500. It would stop near Northlake Mall and Doraville and can serve many unidentified markets.

For express routes from the northern quadrant planned in Stage 1, existing service can be streamlined. The GRTA 400 from Cumming would also stop in Perimeter Center, along with the 401, yet both routes would only provide direct service to Medical Center Station. A new circulator route would be implemented for riders to travel to other parts of the center. The GRTA 400 would continue to Downtown, while the 401 would terminate at the station. This service strategy is similar to that of the MARTA 110 local bus, in which some runs end when meeting the heavy rail system and others run alongside of it

to Downtown (MARTA, n.d.-a). The GRTA 482 from I-75 NW can also have its routing streamlined, such that it can easily be extended to the I-85 NE corridor. Finally, the MARTA express route 240 from Alpharetta can be rerouted to end at Perimeter Center, following the GRTA routes, rather than end at North Springs, as the Stage 1 model showed significant gains from GRTA implementing this strategy.

Druid Hills and Kensington

GRTA identified markets to this center from the US-78 E and I-20 E corridors (Nelson\Nygaard, 2015c). Additionally, based on ARC model desire lines (from Stage 1), OnTheMap (U.S. Census Bureau, 2011), and MARTA's Clifton Corridor rail plans (MARTA, n.d.-b), the importance of this center is quite clear. GRTA later chose not to consider providing service to this center due to lack of "concentrated demand," "roadway constraints," and the presence of other transit service (Wittmann, 2015, slide 30). However, it can be served less directly with intermediate stops on existing GRTA routes and extensions of local bus. The GRTA 419 and 428 from the eastside, for example, can stop on Memorial Drive at the I-285 interchange. Riders then could transfer to MARTA's peak-hour limited-stop route on Memorial Drive (Route 221) (MARTA, n.d.-a). The 221 would be extended to the Clifton Corridor, which is at the heart of the Druid Hills employment center. The current 221 ends at Kensington Station (MARTA, n.d.-a), so an intermediate stop on a GRTA bus would give riders access to the Blue Line. The route, though, is planned to be discontinued in Phase 2 (K. Hayden, personal communication, 2015), apparently due to low ridership. Extending the 221 instead can provide a new opportunity.

Additionally, I-85 NE buses to and from Atlanta can make an intermediate stop on Clairmont Road. Emory's Executive Park shuttle then can be extended to connect riders to the Clifton Corridor. Frequency on this shuttle would be adjusted as a result. Notably, an aerial view shows an appreciable amount of office employment near the

Clairmont part of I-85 (Google, 2015e), and this can be served with this intermediate stop. Finally, the Clairmont stop would also provide riders with access to the MARTA 19, serving the Atlanta VA Medical Center (MARTA, 2015b).

Airport

GRTA has identified markets to the Airport from all over the Atlanta region. Work trips to this center largely come from the southside, though a large number of other trips come from the northern part of the region (Nelson\Nygaard, 2015b). The Airport can be served via intermediate stops on all buses from the southside. The I-75 SE and US-41 S buses, including the reverse commute GRTA 441R[14], would stop on the HOV interchange near the International Terminal, where riders can make their final connections via local bus or shuttle. A new shuttle would be put into the model connecting the interchange to International Terminal, the Delta headquarters area, and the Domestic Terminal. Notably, the MARTA 191 already connects to the International Terminal, though at headways of 30 minutes (MARTA, n.d.-a). The shuttle would provide supplemental frequency matching the arrival of express buses. The I-85 SW buses can stop directly at the Domestic Terminal, as the roadway geometry is well designed for this. This latter terminal is also the terminus of the MARTA Red and Gold Lines (Google, 2015a).

In the long run, GRTA wishes to provide all-day service directly to the airport from the I-75 and I-85 corridors (Nelson\Nygaard, 2015g). The plan tested in this thesis is an interim solution, in which riders can access the Airport during the peak hour on existing routes. Demand also exists from the eastside and westside (Wittmann, 2014b),

[14] Because the GRTA 441R would become an access route to the Airport's International Terminal, it is rerouted in the Experimental Scenario such that it goes through Downtown again before getting onto the Downtown Connector.

such that a new express bus route on the southern half of the I-285 corridor should be considered, but that is beyond the scope of this thesis. With the Experimental Scenario plan, riders can transfer in Downtown either to the MARTA rail or the GRTA 441R to access the Airport.

Cumberland

Like with North Point, GRTA identified a bidirectional market to Cumberland – from further up the I-75 NW corridor and also from central Atlanta (Nelson\Nygaard, 2015b). No freeway service to Cumberland exists from the former origin (MARTA et al., 2012c). From central Atlanta, two peak-hour reverse commute routes exist (CCT 10A and 10B), along with the all-day CCT 10 route (CCT, n.d.-b). However, service could be improved – particularly with streamlining the routing structure while maintaining coverage.

The market from the outer I-75 NW corridor could be served with intermediate stops. One would occur on the upcoming Terrell Mill Road express lane interchange. Routes bound for central Atlanta can also stop on the Cumberland Blvd. interchange, while those bound for Perimeter Center can stop on the Northside / New Northside interchange. Local bus service, including a new circulator route, would be planned to take riders from these interchanges to their final destinations. The new circulator route would be in addition to one that is already planned (Cobb County Government, 2015) and already in the 2020 model.

The market from Central Atlanta could be streamlined by consolidating the CCT reverse commute routes (10A, 10B, and 10C) into a frequent trunk route with local spurs. The 10C to Town Center would be the trunk route, with stops in Cumberland. The 10A and 10B would be truncated to be high-frequency connecting local routes. The routing of these latter two would also be slightly altered to be two-way, to be more efficient, and to

cover more area, including the spillover in Fulton County where MARTA plans to cut service in Phase 1.

Cumberland would also be served by extending two I-85 NE GRTA routes – the 410 to Lindbergh and the 482 to Perimeter Center. Both extensions would go to Town Center and make intermediate stops in the Cumberland area. The former would contribute in serving the reverse commute market, and the latter would serve markets from both I-85 NE and GA-400. Finally, the rerouted GRTA 475, described under Perimeter Center, can make intermediate stops in this area.

Sugarloaf Mills and Gwinnett Place

The Sugarloaf Mills and Gwinnett Place area can be regarded as a terminus employment center for reverse commute routes on the I-85 NE corridor. GCT currently runs a low-frequency reverse commute route from Central Atlanta to this center. GRTA identified this center as a candidate but did not select it for its final market analysis. However, it is adding a new route (GRTA 414) with an intermediate stop here in Horizon 1. Additionally, GRTA routes will be stopping at the GCT P&R lot, in addition to its own P&R lot, which will provide connectivity to GCT local buses (GRTA, mass email, May 1, 2015). Some progress is being made, though it could be improved. Improvements that can be made include (1) adding frequency and intermediate stops on the reverse commute GCT 103A as it approaches Sugarloaf Mills; (2) having the GRTA 416 from Dacula stop on the Sugarloaf Parkway interchange; (3) extending the GRTA 482 (Town Center to Perimeter Center) to this center; (4) adding frequency to the GRTA 414 bus, which would come from additional intermediate stops; and (5) adding a circulator bus route in the area.

Doraville

This is the northeastern terminus of the MARTA Gold Line and where many GCT and MARTA local buses begin (MARTA et al., 2012c). It is also where new mixed use development is planned to replace the closed automobile plant (Trubey, 2015). Many express buses bypass Doraville (MARTA et al., 2012c). However, it has high potential as a hub for polycentric connectivity. Express buses bound for Perimeter Center from the east can stop in Doraville and thus connect the northern termini of the MARTA Red and Gold Lines. An extension of the GRTA 482 from Perimeter Center to Sugarloaf Mills (described above) can also stop in Doraville and serve the same purpose in the reverse direction. Notably, the GRTA 408 begins here and runs two-way north on GA-141 to Johns Creek and Peachtree Corners (GRTA, n.d.-c). The demand from Johns Creek to Perimeter Center stood out in original market analysis desire lines (Nelson\Nygaard, 2015a), and this market can be served via connections to other express buses in Doraville. Most importantly, intermediate stopping in Doraville would provide connections to the MARTA rail, which would serve many smaller markets.

Southlake Mall

Southlake Mall is in Clayton County and is the only employment center identified here that is in the southside and outside of the I-285 Perimeter (Google, 2015o). MARTA has recently began new local bus service in this area (11Alive, 2015a). GRTA identified this center as a candidate but did not select it for its final market analysis (Nelson\Nygaard, 2015c). However, the center can easily be served by having the mainline US-41 South buses – the GRTA 440, 441, and 441R – stop at Mount Zion Road. Riders then can transfer to a MARTA bus to access Southlake Mall (MARTA, 2015b).

Also considered was the possibility of providing local bus access to this center from the Stockbridge P&R lots along the I-75 NE corridor. The GRTA 430 could stop at

these lots, which would provide access from McDonough. However, as shown in the model, there is no exit from the upcoming reversible express lanes to the Stockbridge P&R lots. The 430 would not be able to use the express lanes at all if it were to make an intermediate stop here. Because utility of the express lanes takes priority, the GRTA 430 was not coded to stop at Stockbridge. While local bus can still be extended to provide access to Southlake Mall from the Stockbridge P&R lots, the author deemed this possibility to be too unrelated to the scope of this thesis.

Fulton Industrial

Fulton Industrial has been identified as a significant center from various sources (ARC, 2015) (MARTA, 2012). GRTA considered it but did not select it for its final market analysis (Nelson\Nygaard, 2015c). For the routes using the I-20 W corridor, though, Fulton Industrial can be a quick intermediate stop. The GRTA 463 and 476 can stop on the Fulton Industrial Blvd. interchange and then immediately return to the freeway. Riders can transfer to the local MARTA bus running on the Fulton Industrial Blvd. corridor to reach their final destinations. Additionally, the CCT 30[15] bus, running two-way between HE Holmes Station and Six Flags on I-20 (CCT, n.d.-b), can stop at Fulton Industrial. This would allow Blue Line riders freeway access to Fulton Industrial, as well as allow GRTA bus riders to access to Six Flags and HE Holmes Station. Finally, the GRTA 475 route can be revived and repurposed to run from Mableton to Perimeter Center, stopping in Fulton Industrial to provide access to multiple destinations. In summary, Fulton Industrial can be perceived not only as an employment center, but also as an express bus hub.

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[15] The CCT 25 is also coded in the model to run on the I-20 freeway between Six Flags and HE Holmes Station. The route does not appear on CCT's system map (CCT, 2015b), but it was in the model provided to the author. The first three scenarios were run before the author discovered it. For consistency, the 25 was kept in the model and also coded to stop at Fulton Industrial, even though only the 30 route exists.

Town Center

This can be perceived as the terminus employment center on the I-75 NW corridor. It is close to a shopping mall and Kennesaw State University (KSU) (Google, 2015p). GRTA identified this center in its market analysis report though did not select it for final analysis (Nelson\Nygaard, 2015c). However, in Horizon 1, GRTA is having bypassing buses make an intermediate stop in Town Center (Nelson\Nygaard, 2015f). Currently, CCT runs a reverse commute route to this center – the CCT 10C (CCT, n.d.-b). In the Experimental Scenario, routes would be consolidated to enhance frequency to this center, and two GRTA routes would be extended to provide access from Perimeter Center and Lindbergh Center. In the local area, all three express routes would cover more ground than the current 10C.

Marietta

This smaller center lies between Town Center and Cumberland. It serves as both an origin and destination hub. Currently, CCT operates one express bus to Downtown – the CCT 101. Additionally, the Marietta Transfer Center is currently an intermediate stop on the CCT 10C reverse commute route, although it is a good distance from the I-75 freeway (CCT, n.d.-b). In the 2020 model from ARC, the intermediate stop in Marietta is cut. However, the results of the preliminary scenarios suggest that this center is important to serve. This thesis proposes a plan to serve it in both directions via intermediate freeway ramp stops and local bus connectivity. Additionally, a new P&R lot east of I-75 is proposed based on findings from the Nelson et al. paper (2008). The CCT 101 would be repurposed as two high-frequency, two-way, connecting local bus routes. Both routes' termini would be at the Marietta Transfer Center and the proposed new P&R lot. One route would serve the upcoming Roswell Road interchange, where inbound buses would stop, while the other would serve the North Marietta Parkway interchange for outbound

buses. The 10C would go back to stopping in the Marietta area, but there would not be a significant deviation for riders bound to Town Center.

Indian Trail / Peachtree Corners

Intermediate stopping at Indian Trail for I-85 NE buses is proposed to serve riders from the Indian Trail P&R lot. However, given the employment present in the area (U.S. Census Bureau, 2011), the effectiveness of intermediate stopping can be increased with a two-way local bus connecting this P&R lot to Peachtree Corners. It is proposed that the GCT 102 be repurposed to serve this role. Other express buses on I-85 NE, both inbound and outbound, would stop at or near the Indian Trail P&R lot.

Chamblee-Tucker and Northlake Mall

These nearby smaller centers were identified via Google Maps aerial imagery as having office buildings. Additionally, Mercer University has a campus in the area (Google, 2015d, 2015l). Local MARTA bus service already runs there. Existing and already-planned express bus routes can make intermediate stops in these areas and connect to these routes.

In the Experimental Scenario, the two Perimeter-bound routes from the east quadrant – the GRTA 428 and GRTA 500 – would stop outside Northlake Mall on Lavista Road. Local bus routing would be slightly modified to connect with express buses.

On the I-85 NE corridor, the GRTA 410, bound for Lindbergh Center, would stop at Chamblee-Tucker Road. Local bus routes would connect riders to Chamblee Station, Mercer University, a nearby office park, and Northlake Mall. The 410 is the only inbound bus that would make this stop, as connecting local bus has low frequency. The one outbound bus on I-85 from central Atlanta – the GCT 103A – would stop here as well.

Atlantic Station and Bellemeade

These centers lie along Northside Drive in the city of Atlanta, close to the I-75 corridor. Atlantic Station is a mixed use development directly west of northern Midtown (Atlantic Station, 2015) (Google, 2015c). For Bellemeade, aerial imagery revealed office buildings in the area (Google, 2015m), and OnTheMap shows its census tract to have relatively high population and employment. They are not major focus areas of this thesis. However, the reverse commute CCT 10C bus can easily be routed through these areas on its way to larger I-75 NW employment centers. It would follow the path of the GRTA 483 PM routing (not modeled), going through Atlantic Station on 17th Street, passing the Bellemeade area on Northside Drive, and entering I-75 via designated HOV exits. This routing would (1) provide a last-mile connection for centrally-bound employees who work in this area, and (2) serve reverse commuters living in this part of Atlanta who work on the I-75 NW corridor.

4.3 Concluding Remarks

This final scenario, marking the core of the paper, presents an extensive plan to serve suburban employment demand. Express bus is used as the primary technology, yet local bus connectivity is integrated. Strategies such as intermediate stopping are incorporated, emphasizing that travel demand largely can be served with existing routes. Many centers were identified for potential service. Some centers, most notably Buckhead, were cut from the plan, though they are discussed as further research in Chapter 6. This plan will be tested in a modeled scenario, and Chapter 5 will present the results.

CHAPTER 5

EXPERIMENTAL SCENARIO RESULTS

The results of modeling the Experimental Scenario are overwhelmingly positive. Overall transit ridership increases by over 8,000 trips, and the number of express bus trips increases by almost 50%. Ridership on treated express bus routes rises dramatically, while untreated express routes actually lose boardings. New or substantially modified local bus routes in employment centers also perform well. Node-level results show that a sizeable number of boardings and alightings occur at intermediate stops. This chapter will detail results from region-level, route-level, and node-level perspectives.

5.1 Region Level Results

Table 17 and Table 18 compare the results between the Stage 1 and Experimental Scenarios, with and without application of the air passenger model, respectively. Larger increases in transit ridership are seen between these two scenarios than between the 2020 Base and Stage 1 Scenarios. The reduction in vehicle person trips is also more dramatic. This is not surprising, as unlike the Experimental plan, GRTA's Horizon 1 plan is intended to be cost neutral (Nelson\Nygaard, 2015f). Interestingly, the transit gain for air passengers is quite low compared to that for Stage 1, despite that fact that the Experimental Scenario specifically addressed connectivity to the Airport. The gains for Stage 1 over 2020 Base were likely due to MARTA local bus changes. The potential of attracting air passengers with changes to a peak-only service appears highly limited. Other benefits can be seen, though, with adding the airport stops and shuttle. As shown in

the tables in Appendix F, the gain in transit ridership is seen entirely on HBW trips. The transit share for HBO and NHB trips does not change. As seen in

Table 17, the Regional Congestion Index does not change, as expected, though the transit alternatives presented in this plan seems to attract a sizable number of people. While the model gives little consideration to induced demand (R. Pendyala, personal communication, November 21, 2014), the results show over 7,000 cars being taken off of the road!

Table 17: Results Stage 1 to Experimental with application of the air passenger model

	2020 Stage 1	2020 Experimental	Absolute Change	Percent Change
Transit share	2.17%	2.21%	0.04%	1.84%
Transit trips	411,488	419,729	8,241	2.00%
SOV person trips	11,499,395	11,492,936	-6,459	-0.06%
HOV person trips	7,094,931	7,092,570	-2,361	-0.03%
Total trips	19,005,815	19,005,235	-580	0.00%
Regional Congestion Index	1.26	1.26	0.00	0.00%

Table 18: Results Stage 1 to Experimental without application of the air passenger model

	2020 Stage 1	2020 Experimental	Absolute Change	Percent Change
Transit share	2.02%	2.07%	0.05%	2.48%
Transit trips	380,596	388,705	8,109	2.13%
SOV person trips	11,331,058	11,324,741	-6,317	-0.06%
HOV person trips	7,094,931	7,092,570	-2,361	-0.03%
Total trips	18,806,586	18,806,017	-569	0.00%

Table 17 and Table 18 show the results for transit trips and boardings, respectively, between the Stage 1 and Experimental Scenarios. These numbers do not take into account the air passenger model. A dramatic rise is seen for express bus, both in terms of trips and boardings, with increases of over 12,000. Percent-wise, this is almost a 50% gain for express bus trips. Local bus ridership increases as well, as expected given that this mode was also treated. Heavy rail ridership, though, falls by over 7,000, both for trips and boardings. Despite efforts to integrate heavy rail and express bus, the two modes appear to compete more than complement one another. This result suggests that heavy rail is limited in meeting the dispersed travel demand needs of people in the sprawled Atlanta region. In the Experimental Scenario, buses appear to be successful in filling that void. Dense development around heavy rail stations may be needed to maintain train ridership. Nonetheless, almost 300,000 heavy rail boardings are retained, and this plan highly benefits overall transit ridership.

Table 19: Transit trips, 2020 Stage 1 to Experimental

	2020 Stage 1	2020 Experimental	Absolute change	Percent change
Local bus	135,692	139,336	3,644	2.69%
Express bus	25,110	37,176	12,066	48.05%
Streetcar	0	0	0	
Heavy rail	219,794	212,193	-7,601	-3.46%
Total	380,596	388,705	8,109	2.13%

Table 20: Transit boardings, 2020 Stage 1 to Experimental

	2020 Stage 1	2020 Experimental	Absolute change	Percent change
Local bus	296,245	300,959	4,714	1.59%
Express bus	30,542	42,843	12,301	40.28%
Streetcar	171	178	7	4.09%
Heavy rail	297,772	290,430	-7,342	-2.47%
Total	624,730	634,410	9,680	1.55%

5.2 Route Level Results

5.2.1 Express Bus Boardings

Overall, for treated express bus routes, dramatic gains are seen. The highest absolute gains are on the CCT 102 from Acworth to Midtown. This bus was rerouted to conform with aspects of GRTA's routing in the Midtown area. Additionally, the bus would stop in Town Center, like the GRTA buses in Horizon 1, and it also would stop in Marietta and Cumberland. Frequency was added with these intermediate stops. Percentage-wise, the route with the highest gain was the GRTA 417. This route is new in Horizon 1 and planned to go from Sugarloaf Mills to Perimeter Center. In the Experimental Scenario, this route was extended to Town Center. Additionally, intermediate stops were added at Indian Trail, Doraville, Cumberland, and Marietta. The results consistently show high gains for express buses in which both intermediate stops and frequency was added, with percent gains exceeding 1000%.

For untreated express bus routes, in which neither intermediate stops nor frequency were added, ridership interestingly dropped. The highest absolute drop occurred for the CCT 100 from Town Center to Downtown. This is the most robust CCT express bus route, as seen with model results and frequency. There are several possible reasons for this change: (1) it was rerouted in Downtown to conform with GRTA Horizon 1 routing; (2) added frequency on the GRTA 490 attracted riders away from this route; (3) increased service to Midtown exists via the CCT 102, such that Midtown-bound riders may no longer choose to ride the CCT 100 to Downtown and then transfer, and (4) riders bound to Cumberland and Marietta would no longer need to travel to central Atlanta and then take the reverse commute CCT buses back out. The CCT 100 would lose about 1000 boardings, or 1/3 of its ridership.

Percentage-wise, and heavily striking, the highest drop is with the GRTA 412 from Sugarloaf Mills to Midtown. This route saw a ridership gain in Stage 1, yet in the Experimental Scenario, ridership plummeted from 195 to 10. This is a 95% drop! This is despite keeping frequency, stops, and routing constant. This drop could be due to frequency and stop increases on other routes from Sugarloaf Mills, such as the GRTA 410, 414, and 417. Perhaps for the bulk of riders from Sugarloaf Mills, Midtown is not the final destination. With increased access to surrounding destinations, these riders may not need to travel through Midtown first.

Related to the 412 result and even more interesting is what is observed on the GRTA 414, which also runs between Sugarloaf Mills and Midtown[16], yet has intermediate stops added to it. At the node level, discussed in detail in Section 5.3, the bus becomes empty after it passes the Clairmont Road stop. This is the last stop before the bus reaches Midtown[17]. This suggests even more that very few riders from Sugarloaf Mills are going to Midtown. The numbers would support discontinuing the GRTA 412 and simply relying on the 414 to go to Midtown.

The fact that treated express bus routes have sharp ridership gains and that untreated routes see a decline suggests that nonstop express bus service to destination zones may not be best for the needs of this sprawled region with dispersed travel demand. It maximizes mobility for a relatively small portion of the population while restricting access to a large share. The model results support a plan that would increase the level of access for express bus.

5.2.2 Local Bus Boardings

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[16] The entire route spans from Hamilton Mills to Midtown, with a stop in Sugarloaf Mills and intermediate stops afterward.
[17] Technically, the bus takes the HOV exit toward Downtown first and makes some stops in the Downtown district, such as at Civic Center, on its way to Midtown.

In this scenario, some local bus routes were added or substantially altered. Other routes were largely kept the same, though were slightly altered to connect with intermediate stopping express buses. The new or revamped routes performed well, while the connecting routes kept relatively constant generally saw no increase in ridership.

In each of the centers Cumberland, Perimeter Center, Sugarloaf Mills, and Airport, a circulator route was introduced. Headways were kept between 10 and 15 minutes. The number of boardings on these routes ranged between 602 and 1329. Sugarloaf Mills ranked the highest on the number of boardings, despite being the only one-way circulator route introduced. This result is surprising, as GRTA did not prioritize this area for its market analysis (Nelson\Nygaard, 2015c), and the frequency is relatively low.

The introduced circulator route with the minimum ridership volume was the one in Cumberland. This circulator route was coded in addition to the "existing" one in the 2020 Base and Stage 1 scenarios. Relative to the "existing" circulator route, though, this new one performs quite well. Ridership plummets on the "existing" one from 418 to 35. This "existing" one is currently in the planning stage and can be altered (Cobb County Government, 2015). The results seem to support the author's plan for this route in lieu of the first route coded in the model, as it may better meet the needs of travelers in the area.

Some express or freeway-based bus routes were converted to connecting local buses. This was the case for the CCT 101 from Marietta, the CCT 10A and 10B to Cumberland, the MARTA 140 and 242 in North Point / Windward, and the GCT 102 from Indian Trail. The frequency was increased for all routes, with headways ranging from 10 to 30 minutes. Ridership grew significantly for the most part. The largest increase, both absolute and percent, was on the CCT 101. This result is not surprising, as the route was split into two high-frequency routes spanning the Marietta Transfer Center and a new P&R lot east of I-75. The growth on the GCT 102, converted to a two-way route spanning Indian Trail and Peachtree Corners, was relatively modest, though still at

200%. The only converted route that saw a decline was the MARTA 140. The decline could be due, though, to extending the local routing of the 242. Ridership on the 140 during the peak periods remains at over 1200.

One GRTA express route, the 442 from Riverdale, was completely cut, as riders could use the local MARTA 196 to access US-41 and then transfer to the mainline GRTA 440 or 441. Frequency was increased on all three routes. The MARTA 196 saw a gain of nearly 1000 riders, while the GRTA 440 and 441 saw a combined gain of over 1600 boardings. These numbers are much higher than the 442's Stage 1 ridership of 89.

Two already-local routes in the Druid Hills area were substantially altered to serve the market to the Clifton Corridor from surrounding freeways. These routes are the MARTA 221, a peak-hour limited-stop local bus; and the Emory Executive Park shuttle. The headways for both were 10 minutes, which was a frequency increase for the latter route. Ridership on both routes increased dramatically, with the 221 gaining over 2,500 riders, and the Executive Park shuttle gaining over 1,700. The percent increase in each direction was approximately 2000% or 3500%. For both routes, the primary absolute gain occurs in the direction from the freeway inward. This result supports extending rather than discontinuing the MARTA 221 and it also shows how the Clifton Corridor can be served by express bus without needing to navigate the local roads.

Some existing local bus routes were slightly modified to connect with express routes, though the headway and routing were largely kept constant. On these routes, for the most part, ridership surprisingly declined. It appears that express bus and new/revamped local routes serves markets that before were served by local bus. Ridership on existing GCT local buses declined across the board, though the volumes are still good relatively speaking. Adding intermediate stops on express routes may simply provide a faster alternative for a good portion of riders. Percentage-wise, the heaviest drop on connecting local bus occurred on the MARTA 123, which intersects with the extended MARTA 221. Heavy drops also occurred on the CCT 50, which appears to

compete with new and enhanced routes in Cumberland, and the MARTA 126, which serves Northlake Mall and the Chamblee-Tucker interchange (MARTA, n.d.-a). It appears that express bus simply is a preferred alternative to these lost riders and that they would be inclined to access the express bus directly on foot. Some connecting routes did see ridership increases, such as the MARTA 33 in the Druid Hills area, which saw a gain of roughly 45%.

Astonishingly, the BucRide Red route in central Buckhead, which was untouched, saw a high percentage drop in ridership. This route runs in the Lenox area (BUC, n.d.), where service was not altered. The large size of the transportation analysis zones (TAZ's) may have led the model to predict that riders would choose to walk to an intermediate stop along I-85 rather than take the BucRide and transfer to a parallel local route. The author does not believe that this result would reflect reality. ARC's activity-based model (ABM), which has smaller TAZ's (ARC, 2012), may better predict the effects.

In the Emory area, many of the other shuttles saw a ridership decline, apparently as a result of the enhanced Executive Park shuttle and MARTA 221. Kennesaw State University (KSU) bus routes also saw a decline, apparently because the routing of the three reverse commute express buses to Town Center would provide direct service to outside of the university. Ridership increased for Georgia Tech and Georgia State University buses.

Overall, new and revamped local bus routes saw high ridership success. Other local bus routes did not see such gains, despite connecting with express bus intermediate stops. Further research will be needed to investigate what will make these routes serve as useful first and last mile connections. Nonetheless, the results suggest that high-frequency circulator and feeder routes connecting to express bus would be effective.

5.3 Node Level Results

To evaluate the utility of intermediate stops, the number of boardings and alightings from each stop were measured by stop node. Tables detailing this activity can be found in Appendix H. A high amount of activity was found to occur with express bus routes at these stops, even those that were on freeway ramps. Additionally, a sizable amount of local bus boardings and deboardings occur at these nodes.

The highest number of express bus alightings for a single route occurs in the North Point area on GA-400, where the reverse commute MARTA 243 makes an intermediate stop at Mansell Rd. This stop occurs on the freeway ramp, rather than at Mansell P&R lot, as this is a northbound stop, so this result is noteworthy. Roughly 500 passengers are projected to alight this route. At this stop, 220 passengers would board the MARTA 140, and 80 would board other local routes.

Other express routes with a relatively high number of alightings at a single stop are the CCT 102 at Cumberland South (where I-75 South meets Cumberland Blvd), the GRTA 410 at Lindbergh Station, the CCT 10C (reverse commute) and GRTA 490 (Atlanta-bound) at Cumberland North (Windy Hill and Terrell Mill interchanges), and the GRTA 416 at Clairmont & I-85. The "rankings" are to be interpreted cautiously, as they do not control for the number of stops in a given center nor the number of routes serving a given point. However, they suggest that (1) the strategy of stopping where the freeway ramp intersects the local road has strong potential; (2) the importance of serving the Cumberland area; (3) that serving Lindbergh Center Station on the GRTA 410 has high potential, despite having 0 projected riders in Stage 1; and (4) the potential of an intermediate stop at Clairmont. The office parks around Clairmont Road were not identified as a major employment area, and GRTA's did not identify concentrated demand to Druid Hills from the I-85 corridor. Adding an intermediate stop here, with a connecting local bus extension, only made intuitive geometric sense, yet the results support this strategy.

The stops with the highest number of express bus boardings occur at P&R lots. This result is not surprising, as P&R lots serve as a hub for automobile commuters from a wide range of origins. Ranked highest for single-route boardings are the CCT 102 at Town Center (Big Shanty P&R lot), the GCT 103 at the Sugarloaf Mills GCT P&R lot, the GRTA 482 at Town Center, the MARTA 240 at the Mansell P&R lot, the GRTA 416 at the Indian Trail P&R lot, and the GCT 103A at Lindbergh Center Station. The findings for the CCT 102, GRTA 416, and GCT 103A are noteworthy, as they are intermediate stops added by the author in this scenario. Having the GRTA 416 stop at Indian Trail replaces the lower-performing GCT 102 from earlier scenarios. The boardings result for the GCT 103A at Lindbergh shows the importance of serving the reverse commute market in that area. The intermediate stop on the MARTA 240 at Mansell was present from Stage 1, and it is seen that this strategy is effective. Finally, the number of boardings at the start of the GRTA 482 route shows the potential of an express bus bound for Perimeter Center.

In terms of local bus boardings at the selected nodes, the top five performers occur at MARTA stations, and four of them take place at Lindbergh Center Station. These four are the MARTA 6, MARTA 6S, MARTA 5, and MARTA 39, in descending order based on boardings. The first two go to the Clifton Corridor, so the activity on these illustrates the importance. The 5 and the 39 use local roads to go to Perimeter Center and Doraville, respectively (MARTA, n.d.-a). Although express bus service to Lindbergh Center was enhanced, the contribution of express bus to these boardings is unclear. The other local route with a high number of boardings is the AIRPORT shuttle from the Airport MARTA station, which was newly coded into the model. This result is surprising, considering that the Domestic and International Terminals of the Airport are of the same centroid, and the route is relatively short. However, the route may serve as a key connection from the MARTA rail to local and express routes to Clayton County.

In terms of express bus stops, the top performers for local bus boardings are the Emory Executive Park shuttle at Clairmont & I-85 South, the CCT 101-S at the Roswell Rd & I-75 interchange, the MARTA 140 at Mansell Rd & GA-400 North, the AIRPORT shuttle from the I-75 & Charles Grant Pkwy interchange, and the CCT 10A from the Terrell Mill Rd interchange. All of these nodes are freeway interchanges. The results support the importance of serving the Druid Hills, Marietta, North Point, Airport, and Cumberland areas with express bus and providing local bus connections.

Notably, though, even at freeway interchange stops, not all passengers appear to transfer to a connecting local bus. Many seem to walk to their final destinations. Then again, this result may be skewed by the size of the TAZ's. Also, the model may not be sensitive to possible passenger discomfort at freeway interchange stops. Yet, perhaps many still would prefer to walk to their final destinations.

The local bus with the highest number of alightings at an express bus stop is the GCT 40 at the Sugarloaf Parkway & GA-316 interchange. It appears that there are a large number of passengers coming from Lawrenceville, and adding this stop to the GCT 103 and GRTA 416 buses would provide Lawrenceville residents with greater access. Additionally, some may choose to transfer to the newly coded Sugarloaf Circulator bus.

Other local buses with a high number of alightings is the MARTA 196 at US 41 and Upper Riverdale Road; the CCT 101-S at Roswell Rd & I-75, the GCT 20 at Indian Trail & I-85; and the MARTA 191 near the Airport I-75 HOV exit. The MARTA 196 result can be explained by the discontinuation of the GRTA 442, as these riders would take the 196 instead and transfer to the GRTA 440 or 441 at this node. A similar explanation holds for the CCT 101-S. The GCT 20 phenomenon suggests that a large number of people may access the Indian Trail P&R lot by local bus, to connect to an express bus. The MARTA 191 result suggests that express bus may be useful in serving residents who live along that route.

In terms of less productive nodes, ranking them by single route boardings and alightings is more difficult. Holistically speaking, though, the GRTA P&R lot at Sugarloaf Mills stands out as being unproductive compared with its GCT counterpart, both in terms of boardings and alightings. This could be due to local bus connections at the GCT P&R lot. Then again, capacity constraints may make the GRTA P&R lot more productive in reality. In the Cumberland East area, the intersection of Northside Drive and the I-285 ramps also have modest productivity, though the adjacent New Northside Drive intersection with the ramps has higher productivity. Some of the local stops in employment center areas also have low productivity. Otherwise, though, practically every intermediate stop appears to be worthwhile.

A striking result can be seen in Table 97 with the GRTA 414, as explained in the previous section. When it stops at Clairmont & I-85, all passengers alight, and the bus is empty until it reaches Midtown. Considering that only 10 riders are projected on its parallel GRTA 412 route, it may be the case that Midtown is not the final destination for all passengers from Sugarloaf Mills. In previous scenarios, riders may have transferred from Midtown to a MARTA route to reach their final destinations. Having nonstop service to Midtown from Sugarloaf Mills may no longer be worthwhile. The results would support discontinuing the GRTA 412 and simply having the GRTA 414, with intermediate stops, serve the journey from Sugarloaf Mills to Midtown.

5.4 Concluding Remarks

At the region, route, and node level, the results show high gains with a service strategy that focuses on serving suburban employment centers. Overall transit ridership increases, especially on express bus. Express bus routes with added intermediate stops show strong increases in ridership, and routes without intermediate stops added general experience a ridership drop. Although frequency was increased to compensate for

intermediate stops, node level results show that many riders board and alight at these stops.

CHAPTER 6

CONCLUSIONS

6.1 Findings

This paper investigated the need and the potential for a polycentric service strategy for express bus in the Atlanta region. It focused on serving employment centers outside of central Atlanta, which were identified through various sources. These centers lie predominantly in the northern suburbs, though some centers (such as the Airport) exist in other parts of the region. Service strategies then were modeled for their effectiveness. Because this thesis coincides with COA's from GRTA and MARTA, their short term plans were modeled. These plans move toward a polycentric service strategy. The author then developed a new plan building off of Stage 1 to enhance polycentrism further. The plan consisted of intermediate stopping of existing routes, integration of transit across agencies, and new routing.

Short term plans from GRTA and MARTA, termed Stage 1, were relatively small steps, yet they contributed to appreciable ridership increases, especially for express bus. Intermediate stopping of express bus with frequency increases works especially well, according to the model.

Insight from the Stage 1 scenario and the literature then was applied to develop the Experimental Scenario. In this scenario, ridership increases were dramatic on (1) express buses that were treated with intermediate stops; and (2) high-frequency local bus designed to connect express bus riders to employment. On express buses that were kept nonstop, ridership interestingly *decreased.* This may have been due to central Atlanta not being a final destination for exisiting riders or the frequency increases of the other express buses. Existing local bus with few changes made generally did not experience net

ridership increases. Nonetheless, the results show the need to serve polycentric travel demand, even if Atlanta-bound riders are inconvenienced by intermediate stops, and they show that this plan has strong potential to be successful.

6.2 Limitations and Further Research

This thesis is a beginning to promoting better polycentric connectivity in the Atlanta region. However, there is much additional research to be done on this topic, some of which we detail here.

Modeling Approach

Model Selection

This thesis relies on a four-step trip-based model (TBM) of ARC, which is very limited for today's needs. Next year, ARC's new activity-based model (ABM) will be ready for use in the 2016 TIP Amendment to Plan 2040 (G. Rousseau, presentation, August 28, 2015). By this time, the ABM will also be ready for use for this research question. The ABM has much strength over the TBM when it comes to transit planning. These strengths include:

- **Smaller Transportation Analysis Zones (TAZ's)**. The TAZ's of the TBM were divided into thirds, based specifically on the walking distance to transit (ARC, 2012). This can better predict which travelers to and from the original TBM zones are more likely to ride transit.
- **Better accounting for long-distance commuting**. The TBM is a "gravity model" (ARC, 2011), assuming that people are more likely to travel to employment centers that are close to them. This assumption may be less of a reality in two-worker households. The ABM predicts household make-up and its number of workers, and then it predicts where workers will travel via a multinomial logit model (ARC, 2012).

- **Accounting for return trips**. The TBM uses TRNBUILD for coding transit networks, in which only the AM versions of express routes are coded in the model. Workers are simply assumed to return home in the evening. The ABM, in contrast, uses PT for coding networks, in which the PM route versions are coded into the model (S. Lewandowski, personal communication, April 6, 2015). This may allow for better accounting of routing complexities. Furthermore, it could account for one-way riders who may use express bus for purposes other than work commutes.
- **Time of day**. Currently in the TBM, only peak and off-peak headways can be coded in the model. All GRTA Xpress routes are coded as being peak-only, even though isolated runs exist off peak (GRTA, n.d.-c). In the ABM, the day is divided into five periods, in which different headways can be coded for each one (S. Lewandowski, training session, 2014).
- **Accounting for trip chaining**. The ABM better accounts for travelers making intermediate stops on the way to or from work, such as to pick up children or shop (ARC, 2012). The desire to trip chain could affect transit ridership.
- **Newer data.** The data that form the basis of the TBM are from a 2001-2002 household travel survey (ARC, 2011). The data used for the ABM, though, are from a 2011 household travel survey. This survey was not applied to the TBM due to the costs of maintaining two models (G. Rousseau, presentation, Aug. 28, 2015). Using the ABM can provide estimates based on newer data that reflects more recent trends.

Furthermore, GRTA told the author that transit agencies use their own models rather than those of metropolitan planning organizations (MPO's) such as ARC (L. Beall,

personal communication, December 4, 2014). Transit agency models may provide the level of detail needed before proposed changes can be implemented[18].

Modeling Headways and Their Impacts

This was an unresolved dilemma that arose during the course of the research. Models assume that passenger wait time is half of the headway (S. Lewandowski, personal communication, April 6, 2015), which is based on the assumption of random arrivals (P. Mokhtarian, personal communication, 2015). The random arrival assumption may be appropriate for local travel within a city. However, for longer distance travel, riders may be more likely to arrive based on a schedule. Thus, passenger wait time at the stop is unlikely to be as long as modeled.

Then again, even if riders know when to arrive at the stop, the need to plan around a transit schedule poses an inconvenience. The rider may choose to wait at home or work instead of at the transit stop, yet the amount of time between the traveler's desired departure time and the actual departure time may still negatively impact the probability of taking express bus. This "hidden wait time" needs to be taken into account as well.

Furthermore, modeled headways do not reflect actual headways, as they are simply the 480 peak period minutes divided by the total number of runs (S. Lewandowski, April 6, 2015). That is, they coded on the assumption that runs are evenly distributed throughout the peak period. This is not the case in reality (GRTA, n.d.-c). For example, an express bus route with three runs per peak period is modeled to have 80-minute headways, which is 480 minutes divided by the six total runs. However, those three runs could all occur in the early part of the period, spaced only 30 minutes apart.

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[18] This sentence does *not* imply that models are the sole basis of transit planning decisions. GRTA emphasized to the author that decisions do not come out of models, as many other factors need to be taken into account (L. Beall, personal communication, December 4, 2014).

Thus, the average wait time would be 15 minutes rather than 40 minutes. Then again, by recoding the headways, the model may fail to account for those who wish to travel earlier or later in the period.

Considering everything, ARC's methodology for coding express bus headways was maintained. However, this aspect should receive further research.

Accounting for Induced Demand

Because enhanced transit service is expected to result in a mode shift from the automobile, as desired, latent demand may be induced. According to the theory of triple convergence, as there are fewer cars on the main route, travelers could fill in the gaps by adjusting their route, time of travel, or mode (P. Mokhtarian, personal communication, April 8, 2014). Thus, little difference may take place with the number of automobile trips. The TBM does not account for this phenomenon, as the number of trips produced is assumed to be static (R. Pendyala, personal communication, November 21, 2014). Further research should predict the demand induced as a result of enhancing bus service.

Accounting for Uber, Lyft, and Automated Vehicles

This thesis focused on local transit in serving the first and last mile of transit trips. However, taxi-lites such as Uber and Lyft have the potential to do the same. Some may also choose to use these taxi-lites in lieu of transit for the entire duration of their trips. While the model incorporates traditional taxis (ARC, 2011), different dynamics may occur with taxi-lites. Furthermore, automated vehicles are receiving much attention in the transportation planning world and may have implications for transit ridership.

Accounting for Changing Demographic Trends

With the millennial generation now being more inclined to live in urban environments and drive less (Braunstein, 2015), further research should examine the impacts in terms of express bus ridership. Some may be more inclined to ride transit,

some may be more inclined toward Uber and Lyft, and others may be inclined toward using a combination of both. Other demographic trends are also taking place, such as increasing suburban poverty (Sanburn, 2014), that should be further investigated and modeled.

Broader Planning Goals

Accounting for All Types of Work Commutes

This thesis focused on peak-hour express bus service, which is the norm in the Atlanta region. However, peak-hour service seems to be better suited for commutes to white-collared employment than for commutes to other types of jobs. The plan tested in the Experimental Scenario does provide service to employment centers such as Fulton Industrial and the Airport. However, if work shifts involve travel outside of the peak periods, then express bus service will not be as useful. Further research should examine the possibility of all-day express bus service. GRTA found mid-day service to be the most desired improvement among existing riders (Wittmann, 2014a). It would benefit existing riders, serve new markets, and, as Walker points out, also benefit the bus drivers, as they would no longer need to work split shifts (2012).

Not only does express bus timing arguably favor white-collared workers, but the routing proposed in this paper may do so as well. After all, if express bus is a peak-hour service, routing it to maximize productivity is desired. However, service to other types of employment areas, such as retail and industrial, is necessary as well. The plan proposed in this thesis may be an improvement to serving these types of commutes, but further research is needed in determining how to serve them more effectively.

Serving More than Work Trips

Other trip types can benefit from express bus, and the plan tested in this thesis makes some attempt at serving them. For example, Douglas County riders would now

have express bus access to Six Flags. GRTA is aspiring toward this concept now with all-day service to the Airport and to Downtown (Nelson\Nygaard, 2015g). However, further analysis should be conducted for serving various trip types. This will be especially important as the Atlanta Braves baseball team expect to open a new stadium in Cumberland (Caldwell, 2015).

Corresponding with Other Plans

Other plans were reviewed in the research, though not all were able to be incorporated in the scope of this thesis. Two MARTA plans that were not incorporated are the I-20 East BRT and the Blue Line extension to Stonecrest Mall (MARTA, 2014c). The latter is strongly advocated by the DeKalb County National Association for the Advancement of Colored People (NAACP). The organization came out against a referendum in 2012 to increase transportation funding via a sales tax, as the heavy rail extension was not in the project list (Wheatley, 2012). However, it currently is in MARTA's plans (MARTA, 2014c). Consideration should be given to providing interim express bus service. MARTA is already planning to do this in Phase 2 of its COA plan as a precursor to the I-20 BRT (K. Hayden, personal communication, May 8, 2015). There also should be consideration to doing this for the planned Blue Line extension. In this thesis, consideration was given to adding a stop at Stonecrest Mall for the I-20 East GRTA buses. However, the routes would have only been one-way. It is unknown if Stonecrest Mall would be a trip production center, attraction center, or both, nor is the directionality of demand known. Without adequate knowledge of demand, the addition of this stop is simply recommended as further research.

Serving Buckhead

Buckhead was identified as a potential market for GRTA service (Nelson\Nygaard, 2015c), but GRTA has chosen not to prioritize potential service to this

area, citing “roadway constraints,” a lack of “concentrated demand,” and presence of “alternative transit options (Wittmann, 2015, slide 30). While the author strongly considered serving this area in the Experimental Scenario, he too decided not to incorporate it. Because central Buckhead’s development appears to be centered around the Buckhead MARTA station, providing direct service to this area could be seen as competing with the MARTA rail. Improving service to Perimeter Center and Lindbergh Center could benefit Buckhead indirectly, so the Experimental Scenario simply measured the effects of that. However, serving Buckhead directly can still be modeled and potentially provide even greater benefit. The GRTA 400 can make a quick stop at the Lenox Rd and GA-400 interchange, and the GRTA 410 can detour through central Buckhead while on its way to Lindbergh Center.

Serving Suburban Downtowns

The thesis is focused on serving suburban employment centers, but these centers are car-oriented office parks rather than traditional “main street” settings. An advantage of commuter/regional rail is that railroads tend to run through the hearts of suburban towns. Those who live in suburban downtowns can access the rail without needing a car. Furthermore, those who work in a suburban downtown or simply wish to visit could do so via the train. The proposed Clayton County commuter rail line (Saporta, 2015) has potential for serving these needs, and it could promote growth and economic activity in these centers. However, this would only serve one part of the Atlanta region, and it would not be implemented for years (Saporta, 2015). Express bus can serve as an interim solution. Serving suburban downtowns with express bus is more challenging, as it is a freeway-based service. To address that, the express bus could make intermediate stops on freeway interchanges, and shuttle buses can connect downtowns to the express bus stops.

Serving the South Half of I-285

An idea that was considered was running a new two-way express bus along the south half of the I-285 Perimeter from the Fulton Industrial area to Panola Road and navigating through the Airport. It would make intermediate stops along the way. GRTA identified market potential to the Airport from Mableton and Panola Road (Wittmann, 2014b). The idea was not incorporated in this scenario due to a lack of knowledge about the time of day of travel demand. However, it is recommended for further research.

Greater Attention to the Reverse Commute

Given the broad nature of this thesis, a relatively small amount of attention was able to be spent on the reverse commute specifically. However, it appears to be a growing market (Hartshorn, 2009), especially with the recent boom in multifamily residential construction in the city (11Alive, 2015b). A closer analysis of travel demand from the city to the suburbs should be given. That is, there should be analyses of population areas and how to connect them with express bus using local transit. Another dimension is equity, as low income residents may greatly benefit from express bus for employment in the suburbs. City residents should be able to have convenient access to express bus without needing a car.

Alternative Service Strategies

Other potential service strategies exist that could benefit polycentric commuting. One such strategy is using express bus as a rail feeding service. For example, the GRTA 453 from I-85 SW could terminate at the Airport, where riders would transfer to the MARTA rail. This strategy could benefit MARTA and allow GRTA to run increased service on the same budget. This strategy was not pursued in this paper, as it could give existing riders too much of a shock, but it is recommended for further research. Many other strategies and tweaks can also be considered, such as keeping the GRTA 401 in its

Horizon 1 form (serving all three MARTA stations in Perimeter Center) and having only the GRTA 400 serve just Medical Center Station.

Decentralizing Transit within the City of Atlanta

Another thesis can be written on improving polycentric connectivity within the MARTA system itself. The approach of having bus routes feed into central "rail backbones" favors long-distance commuting from the suburbs. However, it does not properly serve short-distance travel needs within the city. Activity centers and travel patterns exist outside of the MARTA rail lines. Further research should be done to optimize the experience of various travel patterns within the city, using technologies such as BRT, as doing so can help the reverse commute, intracity commute, and express bus ridership. A possibility of a grid-like bus system should be considered, as described by Walker (2012), or the use of a hub-and-spoke system as described by Cervero (1985).

6.3 Closing Remarks

This thesis emphasizes the need for transit in the Atlanta region to serve more than just the central city. This is challenging due to the relatively dispersed nature of travel demand to suburban locations. However, as seen with freeway congestion, the degree of concentration of demand to these centers has become significant and cannot be ignored. In this thesis, a transit plan is developed and investigated to meet the needs of suburban travel demand while also addressing its challenges. With intermediate stops in employment centers, combined with frequent connecting local bus, large ridership gains are seen. Ridership drops are seen on parallel nonstop express buses, despite keeping their frequency constant. The results confirm that transit can be successful in serving many centers rather than one with the proper service strategies. While further research and fine-tuning is recommended, serious consideration should be given to this plan, as it shows how travel needs for a large share of work commuters could successfully be met.

APPENDIX A

TRIP-BASED MODEL OF THE ARC

To test our scenarios, we apply the trip-based travel demand model from the Atlanta Regional Commission (ARC). This trip-based model (TBM) is also known as a four-step model. This model began being used in the mid-20th century and still dominates travel demand modeling (McNally, 2007). ARC is in the late stages of developing a much more complex model, known as an activity-based model (ABM). It is expected to be used for ARC's 2016 TIP[19] Amendment to its Plan 2040 (G. Rousseau, presentation, August 28, 2015). The ABM has many advantages for transit planning. However, it has not yet been fully calibrated and validated, and using it would involve a much greater expense. Therefore, at the time of this thesis, the TBM is chosen. This appendix outlines the four steps of the TBM, then explains the nature of transit coding in the model.

The Four Steps

This appendix provides a simplified description of the four steps in the TBM. The reader is encouraged to refer to the model documentation, cited throughout the appendix, for more details.

Step 1: Trip Generation

ARC's travel demand models cover 20 counties in the Atlanta metro: Fulton, DeKalb, Cobb, Gwinnett, Rockdale, Newton, Henry, Clayton, Coweta, Douglas, Carroll, Paulding, Barrow, Bartow, Forsyth, Hall, Spalding, Fayette, Cherokee, and Walton. This

[19] Transportation Improvement Plan

coverage is required by the United States Environmental Protection Agency (US EPA) to meet air quality goals (ARC, 2011).

The 20-county region is divided into 2,115 transportation analysis zones (TAZ's). Most of these zones are internal and 91 of them are external stations. From each TAZ, trips are produced and attracted, based on household makeup, employment, and other factors (ARC, 2011). Zones that are largely residential are expected mostly to produce trips, and zones that are major employment centers are expected mostly to attract trips.

Trips in the TBM are classified by purpose as follows: home-based work (HBW), home-based shopping, home-based grade school, home-based university, home-based other (HBO), and non-home based (NHB) (ARC, 2011). Scripts[20] used to summarize model results, though, simply use the types HBW, HBO, and NHB.

Step 2: Trip Distribution

The Trip Distribution step classifies the four-step model as a "gravity model." When productions and attractions are determined for each zone, produced trips from each zone are distributed among all zones in the region. Where trips are distributed depends on the number of destinations in each zone and the level of impedance between two zones. Impedance is determined by composite time, consisting of highway and transit travel between zones (ARC, 2011).

Step 3: Mode Choice

In this step, the model predicts the mode of transportation chosen for each trip, using a nested logit model. Automobile trips are in one nest and are further classified into single-occupancy vehicle (SOV) and high-occupancy vehicle (HOV) trips. Transit is in

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[20] This script was provided to the author via email from ARC (S. Lewandowski, personal communication, May 11, 2015)

another nest, further classified by access (walk versus drive) and premium versus non-premium (ARC, 2011). Premium modes are heavy/light rail, commuter rail, BRT/streetcar, and express bus. Non-premium modes are local bus, arterial BRT, arterial express bus, and shuttle bus. Alternative specific constants (ASC's) are present for express bus, BRT, heavy/light rail, and commuter rail, and they are stratified by the three main trip purposes (HBW, HBO, NHB) (ARC, 2011). Transit trips can involve more than one transit technology, but they are each classified into one technology according to a hierarchy. Premium trumps non-premium in terms of classification (J. Nicholson, personal communication, November 25, 2014), and then classification happens further depending on the amount of time that is spent on a mode (S. Lewandowski, personal communication, August 4, 2015). Modeling the mode choice of a trip uses a number of predictive variables, such as travel time, income, and car ownership. Travel time includes both in-vehicle travel time (IVTT) and out-of-vehicle travel time (OVTT). Each minute of OVTT is a greater deterrence than each minute of IVTT. OVTT for transit includes initial waiting and transfer time (ARC, 2011). Wait time is assumed to be half of the headway (S. Lewandowski, personal communication, April 6, 2015). A transfer penalty of 5 minutes is applied for walk-to-transit modes and 10 minutes for drive-to-transit modes (ARC, 2011).

Step 4: Route Assignment

Once trips are split by mode, the model then predicts the route that will be taken. All trips to and from a zone are assumed to begin and end in exactly the same point in the zone, called the centroid. Centroid connectors are used to link trips between centroids and the transportation network (McNally, 2007). Routing is based on travel time, which is adjusted based on congestion. ARC's model loads external-to-external trips onto the roadway network *before* congestion is taken into account, as it is assumed that people from outside of the area are unfamiliar with the region's traffic patterns (ARC, 2011).

From route assignment, traffic volumes, speed, congestion, and more are determined for each roadway link in the model. For transit, boardings and alightings are determined.

Feedback loops

Because the four steps are interrelated, feedback loops are used. Outputs from later steps in the model are used to influence earlier steps, and then the process repeats until "the percent root mean-squared error (%RMSE) in [Method of Successive Averages (MSA)] link volumes is less than 3.5%" (ARC, 2011, p. 235).

Time of Day Assignment

The ARC TBM divides the 24-hour day into four periods, as follows (J. Nicholson, personal communication, November 25, 2014):

1. AM Peak (AM): 6:00 to 10:00 AM
2. Mid-day (MD): 10:00 AM to 3:00 PM
3. PM Peak (PM): 3:00 to 7:00 PM
4. Night (NT): 7:00 PM to 6:00 AM

Periods 1 and 3 are considered peak periods, and the other two are considered off peak. There are four hours in each peak period.

Highway and Transit Coding

ARC's model uses Cube, a transportation modeling software suite from Citilabs. The highway and transit networks are viewed and modified using Cube Base. The highway network serves as a skeleton, and then transit lines are coded into that network. For the trip-based model, TRNBUILD is used to code transit lines (S. Lewandowski, personal communication, April 6, 2015). Most transit routes are coded onto highway links, with the exception of MARTA heavy rail lines.

In a number of ways, transit coding in this model is a simplified form of what actually occurs. For peak-hour express bus running in only one direction, only the AM route is coded, as a one-way route. It is assumed that the traveler would simply return

home in the evening, without needing a transit link explicitly coded in (S. Lewandowski, April 6, 2015).

For any given period and transit route, the model assumes uniform headways through the period. For the coded route, the modeler simply enters the peak and off-peak headways. This uniform headway assumption presents a challenge for modeling express bus, as runs for each route are likely planned based on work schedules. Runs for routes are often relatively few, do not occur throughout the peak period, and do not have uniform headways. Also, the frequency during the AM Peak may differ from that of the PM peak (GRTA, n.d.-c). To account for this phenomenon, ARC simply models express bus peak headways as the quotient of 480 minutes and the total number of runs per day (S. Lewandowski, personal communication, April 6, 2015). (480 minutes is the total length of the AM and PM peak periods combined.) For example, suppose that an express bus route had three runs per period, with AM departures at 6:30, 7:00, and 7:30 and PM departures at 4:00, 4:30, and 5:05. The headways are generally 30 minutes, but buses on this route do not run throughout the peak periods. Thus, the peak headway is coded at 80 minutes, which is the quotient of 480 minutes and 6 runs.

Not all transit routes are coded in the model. For most GRTA Xpress bus routes, there are reverse commute runs back to the originating P&R lot (GRTA, n.d.-c). However, many of these reverse commute routes only run one to two times per period. According to the algorithm above, modeled headways would then range from 120 to 240 minutes. ARC's TBM, though, typically will not board any passengers on transit routes with headways of greater than 90, as a wait time of more than 45 minutes would add too much time to the trip. Therefore, ARC does not typically code reverse commute routes in the model unless it has three or more runs per peak period (S. Lewandowski, personal communication, 2015).

Considering the role of reverse commuting to this thesis, consideration was given to coding these low-frequency reverse commute runs in the model anyway, but capping

the headway at 90 minutes. However, in Horizon 1, GRTA plans to cut all but two reverse commute versions of its routes (A. Poznanksi, personal communication, 2015). This decision makes sense, as nonstop runs to P&R lots in the morning are unlikely to attract ridership without last-mile connectivity. The new reverse commute runs tested in the Experimental Scenario will not reflect these current ones. Thus, coding reverse commute runs that were slated to be discontinued was not prioritized for this paper. However, the reverse direction of the 408 route (408R) was coded, even though it was not present in the model before, as that is planned to stay in Horizon 1. The 408R only has two runs per peak period, so the headway was capped at 90 inutes.

Scenario-specific details of highway and transit coding are described in Appendices B and E.

Data Caution

The data off of which this model is built was collected from 2001 to 2002 (ARC, 2011). ARC did conduct a more recent household travel survey in 2011, but the data have solely influenced its upcoming ABM. ARC does not have the resources to update both the TBM and ABM with new data. Thus, the prior dataset has remained the basis for the TBM (G. Rousseau, presentation, Aug. 28, 2015). The author believes that the findings of the research are still telling, yet they are limited by the age of the data. Fortunately, though, the mode choice model was tweaked with an on-board transit survey conducted in 2009-2010 (ARC, 2011). Nonetheless, further research is recommended when the ABM is fully calibrated and validated.

APPENDIX B

DETAILED STAGE 1 CHANGES

This appendix details the changes of the Stage 1 Scenario and how those changes were coded into the model.

GRTA Xpress Changes

GRTA's planned changes for Horizon 1 includes routing, frequency, and schedule changes. Routing and frequency can be coded in the model. Changes in arrival and departure times, though, cannot. Thus, such changes are not elaborated here. Also, while there are some early-morning, nighttime, and midday runs (GRTA, n.d.-c), all runs are assumed to occur during the peak periods (6-10 AM and 3-7 PM) due to limitations in the model. Changes are modeled simply based on where and how often the buses will run.

GRTA plans to make a number of route-specific changes, as to be described. Another major part of its plan, though, is to make routing more consistent between buses within their respective employment centers. Routing would also be streamlined (Nelson\Nygaard, 2015f). Thus, the presentation of GRTA's Horizon 1 plan will be done in two parts: (1) bus routings within employment centers (Downtown, Midtown, and Perimeter Center), and (2) changes for individual routes, grouped by corridor.

Employment Center Routing

<u>Downtown</u>

The routing in Downtown is grouped by approach, whether the routes come from the northside, eastside, westside, or southside suburbs. All use Peachtree Center Avenue and Courtland Street for north-south travel. All routes except the southside ones will also use Martin Luther King Junior Drive (MLK) and Mitchell Street to provide direct service

to the Federal Center[21] area, which has a high level of employment (Nelson\Nygaard, 2015f). The details for routes from each direction are explained below.

There are two versions of routing from the northside suburbs. Three routes – the 413, 480, and 490 –would enter Downtown using the Williams Street HOV exit. This would be the default routing. However, the other two routes – the 400 and 416 – would first stop at North Avenue station and then enter Downtown. This latter routing is because Cumming and Dacula do not have Midtown-specific routes. The two route versions are shown in [Figures x and y]. All northside routes proceed south on Courtland Street in the morning, then go west to the Federal Center (Nelson\Nygaard, 2015f).

Routes from both eastside and westside suburbs enter Downtown from I-20 at Spring Street. They pass by the Federal Center, proceed east on Mitchell Street and north on Peachtree Center Ave, cut over slightly to the west, and then end at Civic Center Station (Nelson\Nygaard, 2015f).

Routes from the southside suburbs enter Downtown via the Central Avenue HOV exit. They proceed straight north on Central Street and Peachtree Center Avenue, cut over slightly to the west, and end at Civic Center station. This is the only group of buses that will no longer serve the Federal Center directly. This change has been protested by Federal Center riders (Nelson\Nygaard, 2015f) (GRTA public meeting, May 6, 2015) (GRTA, mass email, May 20, 2015). However, with the given roadway geometries, the routes would experience a significant loss of efficiency by deviating to the Federal Center area. Furthermore, the Horizon 1 Service Plan mentions that high number of northern Downtown employees that would significantly benefit (Nelson\Nygaard, 2015f). The walking distance from the planned morning stop is a maximum of four blocks (GRTA,

[21] We use the term "Federal Center" to refer collectively to the Sam Nunn Federal Center, the Martin Luther King Jr. Federal Building, and the Richard B. Russell Federal Building.

mass email, May 20, 2015). Thus, GRTA has kept its routing plan despite concerns (Nelson\Nygaard, 2015f). The plan is shown in [Figure x] below.

Midtown

Midtown routing is largely kept the same. Routes from the northside suburbs take the Williams Street HOV exit from I-75 / I-85 South. They then proceed north on West Peachtree Street. Stops span from the Civic Center MARTA station to the Arts Center MARTA station. Arts Center Station is the terminus of the northside routes. Routes from non-northside suburbs also go north on West Peachtree Street between Civic Center and Arts Center stations. After Arts Center Station, though, they turn around and proceed south on Spring Street, continuing to drop off passengers (Nelson\Nygaard, 2015f).

Perimeter Center

There are four routes in Horizon 1 that provide service to Perimeter Center. The GRTA 401 from the north enters the area from GA-400 on Abernathy Road and proceeds to all three MARTA stations (Sandy Springs, Dunwoody, and Medical Center) in a crescent shape. The GRTA 482 from I-75 NW proceeds in the opposite direction, beginning at Medical Center Station and ending at Sandy Springs Station. The GRTA 417 and 428, from I-85 NE and I-20 E, respectively, enter the area on Ashford-Dunwoody Road and serve the Dunwoody and Medical Center MARTA stations. The GRTA 428 is already existing, though its routing would be streamlined from before (Nelson\Nygaard, 2015f). For all routes, there would be local stops made in addition to the MARTA stations, which are yet to be determined (A. Poznanski, personal communication, April 17, 2015). The author used his best judgment in coding intermediate stops in the model, using centroid connectors and cross streets as guides.

Individual Bus Route Changes

GA-400 Corridor

Currently, Xpress Route 400 runs on the GA-400 corridor from Cumming. Six runs per day (or three per peak period) connect Cumming to Downtown, while seven runs connect Cumming to the North Springs MARTA station (Nelson\Nygaard, 2015f).

In Horizon 1, GRTA plans to redesignate the runs to North Springs station as a new route – Route 401. The 400 would only go to Downtown and remain at six runs per day. The 401 would no longer go to North Springs station. Instead, it would go directly to Perimeter Center, serving its three MARTA stations: Sandy Springs, Dunwoody, and Medical Center. Additionally, the 401 would only have six rather than seven runs per day (Nelson\Nygaard, 2015f).

Route 400 would connect Cumming riders to Downtown and a small part of Midtown. The bus is to exit from the Downtown Connector onto North Avenue, stop at North Avenue station in the southern part of Midtown, then proceed to Downtown. The planned routing is similar to the current routing, except that the AM run terminates at the Federal Center, on Forsyth St. between Martin Luther King Jr. Drive (MLK) and Mitchell St. It does not continue to the State Capitol (at Mitchell St. and Washington St.), as riders can easily access it on foot from the Washington St. & MLK stop (Nelson\Nygaard, 2015f).

For Route 401, in addition to the three MARTA stations, GRTA plans to have additional local stops in the Perimeter Center area. The stop locations, though, have not yet been determined (A. Poznanski, personal communication, April 17, 2015). Thus, local stops have been coded in the model based on the author's best judgment, using centroid connectors and cross streets as guides. .

GA-141 Corridor

GRTA's only route that runs on this corridor is the 408, spanning Doraville station to Johns Creek. The only change[22] for this route in Horizon 1 is a reduction of 1 trip in the reverse commute direction, both during the AM and PM peak periods (Nelson\Nygaard, 2015f).

I-85 NE Corridor

There are several Xpress bus routes on the corridor and many changes. For Route 410, from Sugarloaf Mills to Lindbergh Center station, one run is cut for each peak period. In the Sugarloaf Mills area, it will now serve the GCT P&R lot, in addition to GRTA's P&R lot. Notably, GRTA also plans to discontinue midday service on this route (Nelson\Nygaard, 2015f), though this was never in the model.

There are two Midtown-bound routes on the corridor – the 411 and the 412. The first runs from Hamilton Mills and stops at the Mall of Georgia. The second runs from Sugarloaf Mills. GRTA plans to introduce a new Midtown-bound route – the 414 – which would serve all three areas of the other two routes – Hamilton Mills, the Mall of Georgia, and Sugarloaf Mills. This route would serve early and late trips on these two routes. In Sugarloaf Mills, both the GRTA and GCT P&R lots would be served (Nelson\Nygaard, 2015f) (GRTA, mass email, January 16, 2015).

The two Downtown-bound routes – 413 and 416 – run from Hamilton Mills and Dacula, respectively. Unlike the 411, the 413 does not currently stop at the Mall of Georgia, but it will in Horizon 1. Furthermore, one run is subtracted for each period. The Downtown routing in Horizon 1 will be streamlined. The 413 routing would follow the

[22] Again, while arrival and departure times have changed as well, in both directions, we cannot consider this in the model.

regular streamlined path. The 416, though, would exit onto North Avenue, stop at North Avenue Station, then proceed south to Downtown. Exiting onto North Avenue will be new for this route. This routing change is intended to provide Dacula with better connectivity to Midtown, as it does not have a separate express bus route to this area (Nelson\Nygaard, 2015f).

Finally, a new route – the 417 – will connect Sugarloaf Mills to Perimeter Center, stopping at Dunwoody and Medical Center Stations. In Sugarloaf Mills, the 417 is planned to serve both the GRTA and GCT P&R lots. The frequency will be three runs per peak period (Nelson\Nygaard, 2015f).

US-78 East Corridor

Two routes connect P&R lots on this corridor to Downtown – the 418 and the 424. In Horizon 1, GRTA plans to combine these two routes into one – the 419, and increase the frequency. All three P&R lots will now be served: Snellville, Hewatt Rd, and Stone Mountain. Routing in Downtown will be streamlined (Nelson\Nygaard, 2015f).

I-20 East Corridor

This corridor has three P&R lots: East Conyers, West Conyers, and Panola Rd. GRTA provides Xpress bus service to Downtown, Midtown, and Perimeter Center (Nelson\Nygaard, 2015f).

For Downtown, there currently is a separate route from each P&R lot. GRTA plans to combine these three routes into one – the 426. The frequency on this new route would be much higher than each of the current three routes, with a total of 29 runs per day. Direct, non-stop service would continue to be provided in the morning from each P&R lot for some runs, but then they would all be combined in the PM peak (Nelson\Nygaard, 2015f). Unfortunately, the model lacks the sophistication to account

for the discrepancy between AM and PM routing, so we simply assume that all runs, both in the AM and PM, are combined.

For Midtown, GRTA plans to consolidate its two routes – the 421 and 423 – into just the 423. All three P&R lots would be served on all runs. The frequency would increase from that of each route individually, such that there are 17 runs per day (Nelson\Nygaard, 2015f).

For GRTA's Perimeter Center route, the 428, there are no frequency changes. However, local routing in the Perimeter Center area will be streamlined and match that of the 417 (Nelson\Nygaard, 2015f).

I-75 SE Corridor

There are three routes running from P&R lots along this corridor: one from McDonough, and two from Stockbridge (Nelson\Nygaard, 2015f).

The McDonough route, the 430, currently has runs serving both Downtown and Midtown and other runs serving only Downtown. Service to Midtown, though, is planned to be truncated. All trips would just serve Downtown. Those traveling to Midtown could drive to Stockbridge or transfer to the MARTA rail. Furthermore, there would be a reduction of one run in the PM. To compensate, the last PM run of the 432 to Stockbridge would be extended to McDonough (Nelson\Nygaard, 2015f). This route extension is not accounted for in the model.

The Stockbridge routes, the 431 and 432, serve Midtown and Downtown, respectively. Ridership from Stockbridge is high, so frequency will increase on both. Two daily runs are added to the 431, and one daily run (in the PM) is added to the 432. There are two P&R lots that are near each other in that area. Xpress routes will serve both in Horizon 1 (Nelson\Nygaard, 2015f).

US-41 Corridor

There are three Xpress routes on the corridor – the 440, 441, and 442 – connecting the P&R lots of Hampton, Jonesboro, and Riverdale to Downtown or Midtown (Nelson\Nygaard, 2015f).

In Horizon 1, GRTA plans to restructure the 440 and 441 routes. Currently, the 440 serves Downtown from both Hampton and Jonesboro, and the 441 serves Midtown from Jonesboro. GRTA plans to have both the 440 and 441 each go to both Downtown and Midtown. The originating P&R lots will be the same. The frequency of the 440 bus reduces from 18 to 13 runs, while that of the 441 bus increases from 9 to 12 runs. One of these 441 runs is a midday return trip (Nelson\Nygaard, 2015f). However, it is treated in the model as a peak period trip, as it is assumed that riders on this trip already commuted to central Atlanta during the AM Peak.

The 440 and 441 are the only Atlanta-bound routes in Horizon 1 that will have a reverse commute version (Nelson\Nygaard, 2015f). There will be five runs total, with two reaching Jonesboro in the AM peak and three leaving Jonesboro during the PM (GRTA mass email, May 1, 2015). For reasons explained in a footnote in Chapter 3, these runs are treated as a single route, labeled the 441R, which ends at Jonesboro. According to the algorithm, the number of runs would yield a modeled headway of 96 minutes, yet it is capped at 90. (The details of this approach are described in Appendix A). Although this reverse commute route would have a run leaving at 2:00 PM (GRTA, mass email, May 1, 2015), that run is treated as a peak period run.

For the 442, one run per peak period will be cut, reducing the total daily runs from 12 to 10 (Nelson\Nygaard, 2015f).

I-85 SW Corridor

Currently on this corridor, three routes connect two P&R lots to Downtown and Midtown Atlanta. GRTA plans to consolidate these three routes into one: the 453. This

would connect the Newnan and Union City P&R lots to Downtown and Midtown Atlanta. The frequency on this new route would improve from that of each individual route currently (Nelson\Nygaard, 2015f).

I-20 West Corridor

Like the I-85 SW corridor, three routes connect two P&R lots to Downtown and Midtown. Both P&R lots are in the Douglasville area. GRTA plans to consolidate these into one route: the 463. These would connect the West Douglas P&R lot and the Douglass Multimodal Transportation Center (MMTC) to Downtown and Midtown. The frequency of this combined route will increase from that of the individual routes (GRTA, mass email, May 1, 2015).

US-278 West Corridor

Three routes serve this corridor: the 470, 475, and 477. The 470 and 477 routes connect the Hiram and Powder Springs P&R lots to Downtown and Midtown. GRTA plans to consolidate these two into one new route: the 476. This new route will provide increased frequency. The 475 route runs from Mableton to Downtown. GRTA plans to discontinue it in Horizon 1 (GRTA, mass email, May 1, 2015).

I-75 NW Corridor

GRTA runs several routes on I-75 and I-575, serving Downtown and Midtown from Acworth, Town Center, Woodstock, and Canton. The Xpress Route 480 connects Acworth to Downtown Atlanta. In Horizon 1, this route will stop in Town Center at the Big Shanty P&R lot. Additionally, frequency will be reduced by one run per period. Midday service will also be deleted (GRTA, mass email, May 1, 2015), though this was never modeled.

Routes 481 and 491, from Town Center and Woodstock, respectively, currently go to Midtown Atlanta. They will be combined into a new route – the 483. Frequency

will be increased. In Midtown, the routing will be aligned to that of the other Midtown routes, such that it would not deviate to Peachtree and 10th Streets (as the 481 does). Also, the morning run would terminate at Arts Center Station, as opposed to continuing into the Atlantic Station area. The PM run would continue to serve Atlantic Station (GRTA, mass email, May 1, 2015). However, for this thesis, only the AM version of the route is coded into the model. Those traveling to Atlantic Station are assumed to transfer to the Atlantic Station shuttle.

Route 490 currently connects Canton and Woodstock to Downtown. The same number of trips will take place as before. However, not all trips will serve Canton in Horizon 1. Only five of eight daily runs reach this P&R lot (GRTA, mass email, May 1, 2015). Thus, the numbers 5 and 8 are averaged, and the route is treated as having seven runs, or a headway of 69.

Finally, a new route – the 482 – will serve Perimeter Center from Town Center. There will be four runs per peak period, and the route will travel to all three MARTA stations in the area (GRTA, mass email, May 1, 2015).

Fares

GRTA Xpress routes are operated by different providers, some of whom charge different fares. Most Xpress buses fall into GRTA's fare structure, which divides routes into Blue and Green Zones based on distance. Some buses on the I-85 NE, GA-141, US-78 East corridors, though, are operated by GCT and thus are subject to its fares (GRTA, n.d.-e). In the same sense, some routes on the US-278 West and I-75 NW corridors are operated by CCT and subject to its fares.

The model assumes single per-boarding fares, based on the transit agency and mode. It does not take into account monthly passes or other fluctuations in the per-boarding cost. In the model provided to the author, a fare of $1.75 was coded for most transit modes. In reality, the per-trip fare on transit modes is generally higher. However,

consideration needs to be given to bulk and discounted fares, as well as dollar value changes from the year 2000. Because an analysis of fares is beyond the scope of this paper, the fares were kept the same.

However, some GRTA Xpress buses were redesignated as GCT or CCT express buses. The fare coded for GCT express bus is $2.00 rather than $1.75. Thus, Xpress buses operated by GCT are coded to be more expensive than the other express buses. A holistic review of the real fares between agencies suggests that this relative fare difference is roughly true, so the $2.00 value was kept.

At the time of this research, GRTA had not determined the fares or operating contracts for Horizon 1 (L. Beall, personal communication, May 7, 2015). Thus, it was assumed that they would remain the same. There were two situations in which routes were combined between two operators: (1) Route 418 (GCT) and Route 424 (GRTA) into GRTA 419; and (2) Route 481 (CCT) and Route 491 (GRTA) into Route 483. The 419 was coded as a GCT route, and the 483 was coded as a GRTA route.

Accounting for fare differences between operators, to the extent possible, was done to prepare for the Experimental Scenario, which could involve combining routes between two agencies. Controlling for fares is helpful in interpreting the results.

MARTA bus changes

In Phase 1, MARTA has planned changes for many of its bus routes, both express and local. All of these changes have been coded into the Stage 1 scenario. The analysis has focused on express bus, though a list of all Phase I changes can be found in Appendix I.

Express bus routes

MARTA runs two express bus routes that are expected to change in Phase 1 – the 140 and the 143. Both run on the GA-400 corridor, from North Springs station to the

Alpharetta area. They serve both reverse commutes and inbound commutes (MARTA, n.d.-a).

Route 140

The 140 is an all-day bus that serves North Point Mall directly. Heading north, it exits onto Mansell Road, deviates slightly to the Mansell P&R lot, then proceeds on North Point Parkway. There are three versions of this route. Two of those versions turn onto Haynes Bridge Road, while the other continues north on North Point Pkwy to the Windward P&R lot. The route versions on Haynes Bridge Rd serve downtown Alpharetta, and then one version continues east to Georgia State University's (GSU's) Alpharetta Center (MARTA, n.d.-a). These two Haynes Bridge versions are simply coded in the model as one, with the route ending at GSU.

In Phase 1, the Haynes Bridge versions of Route 140 are planned to be cut. The 140 will just be one route, which proceeds on North Point Pkwy to Old Milton Pkwy (GA-120), heading slightly west to the new Avalon mixed use development, then proceeding north on Westside Parkway to Windward Parkway. It then would go back east to the Windward P&R lot (K. Hayden, personal communication, May 8, 2015).

Route 143

The 143 is a peak-hour bus that serves the Windward Parkway area. In the morning, the bus exits from GA-400 NB onto Windward Parkway, completes a counterclockwise loop using Morris and McGinnis Ferry Roads, stops at the Windward P&R lot, then gets back onto GA-400 SB to North Springs Station. In the evening, the loop occurs clockwise rather than counterclockwise (MARTA, n.d.-a), though that is not modeled here. The intent is to serve both (1) reverse commuters to Windward Parkway employment; and (2) inbound commuters who live in the Windward Parkway area. On some runs, the bus makes a significant deviation to the GSU Alpharetta Center, along

GA-120 (MARTA, n.d.-a). The 143 is modeled as just one route, with the GSU deviation. The frequency of this bus is every 15 minutes.

In Phase 1, MARTA plans to split the 143 into three separate routes – 240, 242, and 243. The 240 would be a frequent, inbound commute bus from Windward Parkway to North Springs station. It would run every 10 minutes. The 242 and 243 are for the reverse commute. The 242 makes a small loop west of GA-400, while the 243 makes a small loop east of GA-400. Because reverse commute service is being split into two separate routes, the headway for both buses doubles from before, from 15 to 30 minutes. The deviation to the GSU Alpharetta Center is cut (K. Hayden, personal communication, May 8, 2015).

Connecting local bus

In the Perimeter Center area, Route 148 runs a peak-hour, two-way route from Medical Center Station west to the Riveredge Parkway area, which borders the Cumberland area (MARTA, n.d.-a). This paper refers to that area as the "Cumberland spillover," as Google aerial imagery shows office buildings there (Google, 2015n). MARTA plans to discontinue this route in Phase 1 (K. Hayden, personal communication, May 8, 2015).

APPENDIX C

REGIONAL MEASURES FOR PRELIMINARY SCENARIOS

Table 21: Trips *without* Application of the Air Passenger Model

	2015 Base	2020 Base	2020 Stage 1
Transit share	2.00%	2.01%	2.02%
Transit trips	351,765	377,195	380,596
SOV person trips	10,535,106	11,332,911	11,331,058
HOV person trips	6,676,498	7,096,628	7,094,931
Total trips	17,563,369	18,806,734	18,806,586

Table 22: Trips *without* Application of the Air Passenger Model - Absolute and Percent Changes

	2015 to 2020 Base Absolute Change	2015 to 2020 Base Percent Change	2020 B to S1 Absolute Change	2020 B to S1 Percent Change
Transit share	0.01%	0.50%	0.01%	0.50%
Transit trips	25,430	7.23%	3,401	0.90%
SOV person trips	797,805	7.57%	-1,853	-0.02%
HOV person trips	420,130	6.29%	-1,697	-0.02%
Total trips	1,243,365	7.08%	-148	0.00%

Table 23: Trips *with* Application of the Air Passenger Model

	2015 Base	2020 Base	2020 Stage 1
Transit share	2.13%	2.14%	2.17%
Transit trips	378,543	407,444	411,488
SOV person trips	10,685,203	11,502,003	11,499,395
HOV person trips	6,676,498	7,096,628	7,094,931
Total trips	17,740,244	19,006,074	19,005,815
Regional Congestion Index	1.21	1.26	1.26

Table 24: Trips *with* Application of the Air Passenger Model - Absolute and Percent Changes

	2015 to 2020 Base Absolute Change	2015 to 2020 Base Percent Change	2020 B to S1 Absolute Change	2020 B to S1 Percent Change
Transit share	0.01%	0.47%	0.03%	1.40%
Transit trips	28,901	7.63%	4,044	0.99%
SOV person trips	816,800	7.64%	-2,608	-0.02%
HOV person trips	420,130	6.29%	-1,697	-0.02%
Total trips	1,265,830	7.14%	-259	0.00%
Regional Congestion Index	0.01%	0.47%	0.00	0.00%

Table 25: HBW trips

	2015 Base	2020 Base	2020 Stage 1
Transit share	5.29%	5.22%	5.23%
Transit trips	203,864	221,847	222,310
SOV person trips	3,153,371	3,478,152	3,477,756
HOV person trips	496,367	553,241	553,442
Total trips	3,853,603	4,253,239	4,253,507

Table 26: HBW Trips - Absolute and Percent Changes

	2015 to 2020 Base Absolute Change	2015 to 2020 Base Percent Change	2020 B to S1 Absolute Change	2020 B to S1 Percent Change
Transit share	-0.07%	-1.32%	0.01%	0.19%
Transit trips	17,983	8.82%	463	0.21%
SOV person trips	324,781	10.30%	-396	-0.01%
HOV person trips	56,874	11.46%	201	0.04%
Total trips	399,636	10.37%	268	0.01%

Table 27: HBO Trips

	2015 Base	2020 Base	2020 Stage 1
Transit share	1.31%	1.29%	1.31%
Transit trips	108,587	113,709	115,757
SOV person trips	4,079,948	4,342,349	4,341,462
HOV person trips	4,119,151	4,352,126	4,350,618
Total trips	8,307,686	8,808,184	8,807,837

Table 28: HBO Trips - Absolute and Percent Changes

	2015 to 2020 Base Absolute Change	2015 to 2020 Base Percent Change	2020 B to S1 Absolute Change	2020 B to S1 Percent Change
Transit share	-0.02%	-1.53%	0.02%	1.55%
Transit trips	5,122	4.72%	2,048	1.80%
SOV person trips	262,401	6.43%	-887	-0.02%
HOV person trips	232,975	5.66%	-1,508	-0.03%
Total trips	500,498	6.02%	-347	0.00%

Table 29: NHB trips

	2015 Base	2020 Base	2020 Stage 1
Transit share	0.73%	0.72%	0.74%
Transit trips	39,314	41,639	42,529
SOV person trips	3,301,786	3,512,410	3,511,840
HOV person trips	2,060,980	2,191,261	2,190,872
Total trips	5,402,081	5,745,310	5,745,241

Table 30: NHB Trips - Absolute and Percent Changes

	2015 to 2020 Base Absolute Change	2015 to 2020 Base Percent Change	2020 B to S1 Absolute Change	2020 B to S1 Percent Change
Transit share	-0.01%	-1.37%	0.02%	2.78%
Transit trips	2,325	5.91%	890	2.14%
SOV person trips	210,624	6.38%	-570	-0.02%
HOV person trips	130,281	6.32%	-389	-0.02%
Total trips	343,229	6.35%	-69	0.00%

Table 31: Transit Trips by Mode

	2015 Base	2020 Base	2020 Stage 1
Local bus	122,650	130,777	135,692
Express bus	16,881	20,101	25,110
Streetcar	0	0	0
Heavy rail	212,234	226,317	219,794
Total	351,765	377,195	380,596

Table 32: Transit Trips by Mode - Absolute and Percent Changes

	2015 to 2020 Base Absolute Change	2015 to 2020 Base Percent Change	2020 B to S1 Absolute Change	2020 B to S1 Percent Change
Local bus	8,127	6.63%	4,915	3.76%
Express bus	3,220	19.07%	5,009	24.92%
Streetcar	0		0	
Heavy rail	14,083	6.64%	-6,523	-2.88%
Total	25,430	7.23%	3,401	0.90%

Table 33: Transit Boardings by Mode

	2015 Base	2020 Base	2020 Stage 1
Local bus	263,582	282,580	296,245
Express bus	21,604	25,585	30,542
Streetcar	186	192	171
Heavy rail	283,459	306,534	297,772
Total	568,831	614,891	624,730

Table 34: Transit Boardings by Mode - Absolute and Percent Changes

	2015 to 2020 Base Absolute Change	2015 to 2020 Base Percent Change	2020 B to S1 Absolute Change	2020 B to S1 Percent Change
Local bus	18,998	7.21%	13,665	4.84%
Express bus	3,981	18.43%	4,957	19.37%
BRT	6	3.23%	-21	-10.94%
Heavy rail	23,075	8.14%	-8,762	-2.86%
Total	46,060	8.10%	9,839	1.60%

APPENDIX D

BOARDINGS BY ROUTE FOR PRELIMINARY SCENARIOS

Express Bus Results

Table 35: Express Bus Boardings – 2015 vs. 2020 Base Scenario[23]

Route	Location	2015 Boardings	2020 Boardings	Absolute Change 2015 to 2020	Percent Change 2015 to 2020
MARTA					
140A A	North Springs to North Point / GSU and back	672	685	13	1.93%
140A B		297	331	34	11.45%
140W A	North Springs to North Point / Windward and back	570	602	32	5.61%
140W B		533	671	138	25.89%
143	N.S. to Windward and back	1028	1426	398	38.72%
CCT					
10C	Midtown to Town Center24	417	196	-221	-53.00%
100	Town Center to Downtown	983	2686	1703	173.25%
101	Marietta to Downtown	298	132	-166	-55.70%
102	Acworth to Midtown	211	445	234	110.90%
GCT					
101	Mall of GA to Downtown	332	408	76	22.89%
102	Indian Trail to Downtown	122	148	26	21.31%
103	Sugarloaf Mills to Downtown	1233	1301	68	5.52%
103A	Atlanta to Sugarloaf Mills	31	30	-1	-3.23%
GRTA					
400	Cumming to Downtown	0	42	42	
400A	Cumming to North Springs	18	31	13	72.22%
408	Doraville to Johns Creek	276	287	11	3.99%
408R	Reverse of 408	59	65	6	10.17%
410	Sugarloaf Mills to Lindbergh	10	15	5	50.00%

[23] The numbers presented are simply model results and are not actual ridership counts. The focus of the paper is on analyzing change and trends. Fortunately, though, we have observed 2014 ridership counts for GRTA Xpress buses. A comparison of these counts with 2015 outputs can be found in the Appendix.
[24] The 2015 version of the 10C stops in Marietta. The 2020 version does not.

Table 35 continued

411	Hamilton Mills / Mall of GA to Midtown	197	230	33	16.75%
412	Sugarloaf Mills to Midtown	86	88	2	2.33%
412R	Reverse of 412	11	10	-1	-9.09%
413	Hamilton Mills to Downtown	134	186	52	38.81%
416	Dacula to Downtown	196	262	66	33.67%
418	Snellville / Hewatt Rd. to Downtown	540	515	-25	-4.63%
420	West Conyers to Downtown	468	627	159	33.97%
420R	Reverse of 420	7	6	-1	-14.29%
421	West Conyers to Midtown	68	74	7	8.24%
422	Panola Rd. to Downtown	85	92	45	12.40%
423	East Conyers / Panola Rd. to Midtown	363	408	45	12.40%
424	Stone Mountain to Downtown	25	27		
425	East Conyers to Downtown	1274	1085		
428	West Conyers / Panola Rd. to Perimeter	18	15	-3	-16.67%
430	McDonough to Downtown	623	600	-23	-3.69%
430A	McDonough to Downtown / Midtown	415	408	-7	-1.69%
431	Stockbridge to Midtown	207	221	14	6.76%
431R	and back	43	48	5	11.63%
432	Stockbridge to Downtown	1742	1859	117	6.72%
432R	and back	16	20		
440	Hampton to Downtown	1713	1961	248	14.48%
440R	Reverse of 440	66	73	7	10.61%
441	Jonesboro to Midtown	30	29	-1	-3.33%
442	Riverdale to Downtown	112	121	9	8.04%
442R	Reverse of 442	0	0	0	
450	Newnan / Union City to	417	416	-1	-0.24%
451/455	Downtown / Midtown	125	139	14	11.20%
460	West Douglas / Douglas	1218	1228	10	0.82%
461/462	MMTC to Downtown / Midtown	637	654	17	2.67%
470	Hiram / Power Springs to Downtown	907	890	-17	-1.87%
475	Mableton to Downtown	0	0	0	
477	Hiram / Powder Springs to Midtown	541	540	-1	-0.18%
480	Acworth to Downtown	188	186	-2	-1.06%
481	Town Center to Midtown	0	1	1	

Table 35 continued

490	Canton / Woodstock to Downtown	151	340	189	125.17%
491	Woodstock to Midtown	185	393	208	112.43%

Table 36: Express Bus Boardings per Run - 2015 vs 2020 Base - Aggregate

Base Routes	Stage 1 Routes	2020 Base Boardings	Stage 1 Boardings	Absolute Change	Percent Change
MARTA					
140A A 140W A	140W A	39	40	1	2.56%
140A B 140W B	140W B	26	31	5	19.23%
143	240 242 243	16	22	6	37.50%
CCT					
10C	10C	35	16	-19	-54.29%
100	100	45	122	77	171.11%
101	101	27	12	-15	-55.56%
102	102	18	37	19	105.56%
GCT					
101	101	18	23	5	27.78%
102	102	11	13	2	18.18%
103	103	36	38	2	5.56%
103A	103A	6	6	0	0.00%
GRTA					
400	400	5	27.78%	7	
400A	401	2	18.18%	1	33.33%
408	408	2	5.56%	1	2.86%
408R	408R	0	0.00%	1	8.33%
410	410	5	27.78%	1	100.00%
411 412	411 412 414	2	18.18%	2	22.22%
413	413	2	5.56%	4	40.00%
416	416	0	0.00%	6	37.50%
418 424	419	5	27.78%	-1	-4.17%
421 423	423	2	18.18%	2	8.70%

Table 36 continued

420 422 425	426	2	5.56%	-1	-2.08%
428	428	0	0.00%	0	0.00%
430 430A 431	430 431	5	27.78%	0	0.00%
432	432	2	18.18%	6	6.52%
440 441	440 441	2	5.56%	7	10.61%
440R	441R	0	0.00%	0	0.00%
442	442	5	27.78%	1	11.11%
450 451/455	453	2	18.18%	0	0.00%
460 461/462	463	2	5.56%	1	1.56%
470 477 475	476	0	0.00%	-1	-1.92%
480	480	5	27.78%	0	0.00%
481 491	483	2	18.18%	11	110.00%
490	490	2	5.56%	24	126.32%

Table 37: Express Bus Boardings – 2020 Stage 1 Scenario

Route	Location	Boardings	Boardings/run
MARTA			
140W A	North Springs to North Point / Windward and back	1022	64
140W B		961	60
240	Windward and Mansell to North Springs	1335	28
242	North Springs to Windward	178	11
243		108	7
CCT			
10C	Midtown to Town Center	197	16
100	Town Center to Downtown	2850	130
101	Marietta to Downtown	139	13
102	Acworth to Midtown	450	38
GCT			
101	Mall of GA to Downtown	416	23
102	Indian Trail to Downtown	135	12
103	Sugarloaf Mills to Downtown	1279	38
103A	Downtown / Midtown to Sugarloaf Mills	30	6

Table 37 continued

GRTA			
400	Cumming to Downtown	28	5
401	Cumming to Perimeter Center	92	15
408	Doraville to Peachtree Corners and Johns Creek, and back	131	22
408R		65	13
410	Sugarloaf Mills to Lindbergh	0	0
411	Hamilton Mills / Mall of GA to Midtown	165	15
412	Sugarloaf Mills to Midtown	195	18
413	Hamilton Mills / Mall of GA to Downtown	145	13
414	Hamilton Mills / Mall of GA / Sugarloaf Mills to Midtown	60	9
416	Dacula to Downtown	298	25
417	Sugarloaf Mills to Perimeter Center	16	3
419	Snellville and Stone Mtn. to Downtown	749	37
423	E & W Conyers and Panola to Downtown	1062	62
426	E & W Conyers and Panola to Downtown	4421	158
428	West Conyers and Panola Rd. to Perimeter	31	4
430	McDonough to Downtown	991	66
431	Stockbridge to Midtown	384	27
432	Stockbridge to Downtown	1771	89
440	Hampton / Jonesboro to Downtown / Midtown	1666	128
441	Jonesboro to Downtown / Midtown and back	1147	96
441R		43	9
442	Riverdale to Downtown	89	9
453	Newnan / Union City to Downtown / Midtown	920	54
463	West Douglas / Douglas MMTC to Downtown / Midtown	2265	98
476	Hiram / Powder Springs to Downtown / Midtown	1763	98
480	Acworth / Town Center to Downtown	38	4
482	Town Center to Perimeter Center	110	14
483	Woodstock / Town Center to Midtown	724	52
490	Canton / Woodstock / Town Center to Downtown	72	10

Table 38: Express Bus Boardings – 2020 Base vs. Stage 1 – Aggregate

Base Routes	Stage 1 Routes	2020 Base Boardings	Stage 1 Boardings	Absolute Change	Percent Change
MARTA					
140A A 140W A	140W A	1287	1022	-265	-20.59%
140A B 140W B	140W B	1002	961	-41	-4.09%
143	240 242 243	1426	1621	195	13.67%
CCT					
10C	10C	196	197	1	0.51%
100	100	2686	2850	164	6.11%
101	101	132	139	7	5.30%
102	102	445	450	5	1.12%
GCT					
101	101	408	416	8	1.96%
102	102	148	135	-13	-8.78%
103	103	1301	1279	-22	-1.69%
103A	103A	30	30	0	0.00%
GRTA					
400	400	42	28	-14	-33.33%
400A	401	31	92	61	196.77%
408	408	287	131	-156	-54.36%
408R	408R	65	65	0	0.00%
410	410	15	0	-15	-100.00%
411 412	411 412 414	318	420	102	32.08%
413	413	186	145	-41	-22.04%
416	416	262	298	36	13.74%
418 424	419	542	749	207	38.19%
421 423	423	482	1062	580	120.33%
420 422 425	426	1804	4421	2617	145.07%
428	428	15	31	16	106.67%
430 430A 431	430 431	1229	1375	146	11.88%
432	432	1859	1771	-88	-4.73%

Table 38 continued

440 441	440 441	2034	2813	779	38.30%
440R	441R	29	43	14	48.28%
442	442	121	89	-32	-26.45%
450 451/455	453	555	920	365	65.77%
460 461/462	463	1882	2265	383	20.35%
470 477 475	476	1430	1763	333	23.29%
480	480	186	38	-148	-79.57%
481 491	483	394	724	330	83.76%
490	490	340	72	-268	-78.82%

Table 39: Express Bus Boardings Per Run – 2020 Base vs. Stage 1 – Aggregate

Base Routes	Stage 1 Routes	2020 Base BPR	Stage 1 BPR	Absolute Change	Percent Change
MARTA					
140A A 140W A	140W A	40	64	24	60.00%
140A B 140W B	140W B	31	60	29	93.55%
143	240 242 243	22	20	-2	-9.09%
CCT					
10C	10C	16	16	0	0.00%
100	100	122	130	8	6.56%
101	101	12	13	1	8.33%
102	102	37	38	1	2.70%
GCT					
101	101	23	23	0	0.00%
102	102	13	12	-1	-7.69%
103	103	38	38	0	0.00%
103A	103A	6	6	0	0.00%
GRTA					
400	400	7	5	-2	-28.57%
400A	401	4	15	11	275.00%
408	408	36	22	-14	-38.89%
408R	408R	13	13	0	0.00%

Table 39 continued

410	410	2	0	-2	-100.00%
411 412	411 412 414	11	14	3	27.27%
413	413	14	13	-1	-7.14%
416	416	22	25	3	13.64%
418 424	419	23	37	14	60.87%
421 423	423	25	62	37	148.00%
420 422 425	426	47	158	111	236.17%
428	428	2	4	2	100.00%
430 430A 431	430 431	44	47	3	6.82%
432	432	98	89	-9	-9.18%
440 441	440 441	73	113	40	54.79%
440R	441R	4	9	5	125.00%
442	442	10	9	-1	-10.00%
450 451/455	453	24	54	30	125.00%
460 461/462	463	65	98	33	50.77%
470 477 475	476	51	98	47	92.16%
480	480	17	4	-13	-76.47%
481 491	483	21	52	31	147.62%
490	490	43	10	-33	-76.74%

Table 40: Express Bus Boardings– 2020 Base vs. Stage 1 – Disaggregate

Base Routes	Stage 1 Routes	2020 Base Boardings	Stage 1 Boardings	Absolute Change	Percent Change
MARTA					
140W A	140W A	602	1022	420	69.77%
140W B	140W B	671	961	290	43.22%
GRTA					
411	411	230	165	-65	-28.26%
412	412	88	195	107	121.59%
430 430A	430	1008	991	-17	-1.69%
430	430	600	991	391	65.17%
431	431	221	384	163	73.76%
440	440	1961	1666	-295	-15.04%
441	441	73	1147	1074	1471.23%

Heavy Rail Results

Table 41: Heavy Rail Boardings - 2015 to 2020 Base

Route	2015 Base	2020 Base	Absolute change	Percent change
BLUE	16142	17562	1420	8.80%
BLUE-	33792	38169	4377	12.95%
GREEN	4569	5028	459	10.05%
GREEN-	5763	6444	681	11.82%
GOLD	20907	22723	1816	8.69%
GOLD-	27645	29990	2345	8.48%
RED	17847	17257	-590	-3.31%
RED-	33908	37699	3791	11.18%

Table 42: Heavy Rail Boardings - 2020 Base vs. Stage 1

Route	2020 Base	2020 Stage 1	Absolute change	Percent change
BLUE	17562	16970	-592	-3.37%
BLUE-	38169	33682	-4487	-11.76%
GREEN	5028	4841	-187	-3.72%
GREEN-	6444	5812	-632	-9.81%
GOLD	22723	22859	136	0.60%
GOLD-	29990	28822	-1168	-3.89%
RED	17257	17461	204	1.18%
RED-	37699	36036	-1663	-4.41%

Local Bus Results

Table 43: Local Bus Boardings 2015 to 2020 Base

Agency	Route	2015 Base	2020 Base	Absolute Change	Percent Change
MARTA	1A	681	730	49	7%
MARTA	1B	484	525	41	8%
MARTA	2	501	514	13	3%
MARTA	-2	452	490	38	8%
MARTA	3A	10	10	0	0%
MARTA	3B	38	40	2	5%
MARTA	4A	165	188	23	14%
MARTA	4B	288	322	34	12%
MARTA	5	1542	1636	94	6%
MARTA	-5	1685	1808	123	7%
MARTA	6	999	1089	90	9%
MARTA	-6	1672	1662	-10	-1%
MARTA	6S	716	794	78	11%
MARTA	6S-	1475	1436	-39	-3%
MARTA	8	205	227	22	11%
MARTA	-8	168	184	16	10%
MARTA	9	203	237	34	17%
MARTA	-9	523	632	109	21%
MARTA	12	632	674	42	7%
MARTA	-12	572	678	106	19%
MARTA	12S	483	518	35	7%
MARTA	12S-	459	540	81	18%
MARTA	13	28	34	6	21%
MARTA	-13	92	100	8	9%
MARTA	15A	835	924	89	11%
MARTA	15B	320	348	28	9%
MARTA	15C A	484	538	54	11%
MARTA	15C B	265	285	20	8%
MARTA	16A	714	786	72	10%
MARTA	16B	481	533	52	11%
MARTA	19	774	831	57	7%
MARTA	-19	662	733	71	11%
MARTA	21A	669	769	100	15%
MARTA	21B	651	570	-81	-12%
MARTA	24	29	35	6	21%
MARTA	-24	32	81	49	153%
MARTA	25A	106	109	3	3%
MARTA	25A-	72	76	4	6%

Table 43 continued

MARTA	25B	184	164	-20	-11%
MARTA	25B-	166	164	-2	-1%
MARTA	26	266	329	63	24%
MARTA	-26	260	279	19	7%
MARTA	27A	559	660	101	18%
MARTA	27B	471	523	52	11%
MARTA	30A	266	289	23	9%
MARTA	30B	464	534	70	15%
MARTA	32A	489	520	31	6%
MARTA	32B	1107	1162	55	5%
MARTA	33A	88	103	15	17%
MARTA	33B	58	68	10	17%
MARTA	34	142	163	21	15%
MARTA	-34	439	500	61	14%
MARTA	36	109	114	5	5%
MARTA	-36	171	170	-1	-1%
MARTA	37A	162	174	12	7%
MARTA	37B	332	351	19	6%
MARTA	39A	1423	1543	120	8%
MARTA	39B	1785	1921	136	8%
MARTA	42A	288	304	16	6%
MARTA	42B	343	377	34	10%
MARTA	47N	397	450	53	13%
MARTA	47S	299	323	24	8%
MARTA	49A	562	615	53	9%
MARTA	49B	1076	1128	52	5%
MARTA	50	33	37	4	12%
MARTA	-50	25	29	4	16%
MARTA	51A	117	160	43	37%
MARTA	51B	510	418	-92	-18%
MARTA	53	3	4	1	33%
MARTA	-53	3	5	2	67%
MARTA	55A	958	1043	85	9%
MARTA	55B	1779	1833	54	3%
MARTA	56	120	133	13	11%
MARTA	-56	91	101	10	11%
MARTA	58	200	214	14	7%
MARTA	-58	121	157	36	30%
MARTA	60	270	293	23	9%
MARTA	-60	687	762	75	11%
MARTA	66	65	72	7	11%
MARTA	-66	105	110	5	5%

Table 43 continued

MARTA	67A	25	30	5	20%
MARTA	67B	34	44	10	29%
MARTA	68	11	13	2	18%
MARTA	-68	114	126	12	11%
MARTA	71	697	767	70	10%
MARTA	-71	1914	2039	125	7%
MARTA	73A	1203	1299	96	8%
MARTA	73B	517	564	47	9%
MARTA	74A	268	288	20	7%
MARTA	74B	439	484	45	10%
MARTA	75	1033	1096	63	6%
MARTA	-75	770	886	116	15%
MARTA	78A	251	273	22	9%
MARTA	78B	453	595	142	31%
MARTA	81	16	18	2	13%
MARTA	-81	10	11	1	10%
MARTA	82	95	103	8	8%
MARTA	-82	202	253	51	25%
MARTA	83	495	539	44	9%
MARTA	-83	1480	1561	81	5%
MARTA	84	437	475	38	9%
MARTA	-84	719	775	56	8%
MARTA	85A	784	769	-15	-2%
MARTA	85B	372	400	28	8%
MARTA	86	393	440	47	12%
MARTA	-86	698	895	197	28%
MARTA	87	696	767	71	10%
MARTA	-87	942	1034	92	10%
MARTA	89	699	755	56	8%
MARTA	-89	1008	1111	103	10%
MARTA	93A	36	42	6	17%
MARTA	93B	35	39	4	11%
MARTA	95	2182	2403	221	10%
MARTA	-95	1180	1249	69	6%
MARTA	99A	27	29	2	7%
MARTA	99A-	38	38	0	0%
MARTA	99B	18	21	3	17%
MARTA	99B-	20	22	2	10%
MARTA	102	465	499	34	7%
MARTA	-102	564	567	3	1%
MARTA	103A	241	260	19	8%
MARTA	103B	244	265	21	9%

Table 43 continued

MARTA	104A	37	47	10	27%
MARTA	104B	177	192	15	8%
MARTA	107	701	603	-98	-14%
MARTA	-107	1534	1677	143	9%
MARTA	110	763	908	145	19%
MARTA	-110	1034	1029	-5	0%
MARTA	110A	721	867	146	20%
MARTA	110A-	883	868	-15	-2%
MARTA	111	227	236	9	4%
MARTA	-111	369	606	237	64%
MARTA	114	303	351	48	16%
MARTA	-114	310	346	36	12%
MARTA	115	390	412	22	6%
MARTA	-115	1373	1827	454	33%
MARTA	116	370	380	10	3%
MARTA	-116	1216	1364	148	12%
MARTA	117	353	386	33	9%
MARTA	-117	1043	1196	153	15%
MARTA	119	34	39	5	15%
MARTA	-119	103	120	17	17%
MARTA	120	1365	1506	141	10%
MARTA	-120	1871	2078	207	11%
MARTA	121	952	1007	55	6%
MARTA	-121	1601	1832	231	14%
MARTA	123	34	37	3	9%
MARTA	-123	62	70	8	13%
MARTA	124	663	732	69	10%
MARTA	-124	1100	1176	76	7%
MARTA	125A	948	990	42	4%
MARTA	125B	726	787	61	8%
MARTA	126A	323	348	25	8%
MARTA	126B	380	428	48	13%
MARTA	132	529	579	50	9%
MARTA	-132	515	537	22	4%
MARTA	148A	286	271	-15	-5%
MARTA	148B	123	140	17	14%
MARTA	150	117	132	15	13%
MARTA	-150	252	263	11	4%
MARTA	153A	288	318	30	10%
MARTA	153B	53	59	6	11%
MARTA	155A	14	17	3	21%
MARTA	155B	24	26	2	8%

Table 43 continued

MARTA	162	256	276	20	8%
MARTA	-162	646	694	48	7%
MARTA	165	263	284	21	8%
MARTA	-165	577	617	40	7%
MARTA	170	14	15	1	7%
MARTA	-170	14	15	1	7%
MARTA	172A	60	59	-1	-2%
MARTA	172B	89	93	4	4%
MARTA	178A	370	399	29	8%
MARTA	178B	402	491	89	22%
MARTA	180A	414	464	50	12%
MARTA	180B	637	724	87	14%
MARTA	180S A	184	222	38	21%
MARTA	180S B	329	379	50	15%
MARTA	181A	177	192	15	8%
MARTA	181B	220	243	23	10%
MARTA	183A	71	76	5	7%
MARTA	183B	37	40	3	8%
MARTA	185A	357	364	7	2%
MARTA	185B	665	669	4	1%
MARTA	186A	904	960	56	6%
MARTA	186B	251	257	6	2%
MARTA	189	146	171	25	17%
MARTA	-189	476	522	46	10%
MARTA	191A	420	612	192	46%
MARTA	191B	272	184	-88	-32%
MARTA	192	1442	1542	100	7%
MARTA	-192	925	997	72	8%
MARTA	193	240	284	44	18%
MARTA	-193	219	203	-16	-7%
MARTA	193S	60	71	11	18%
MARTA	193S-	56	63	7	13%
MARTA	194A	409	384	-25	-6%
MARTA	194B	175	170	-5	-3%
MARTA	195A	205	227	22	11%
MARTA	195B	216	230	14	6%
MARTA	196A	1030	1336	306	30%
MARTA	196B	654	688	34	5%
MARTA	197A		145		
MARTA	197B		137		
MARTA	198		103		
MARTA	-198		69		

Table 43 continued

MARTA	221A	583	638	55	9%
MARTA	221B	187	197	10	5%
CCT	10N	2690	3140	450	17%
CCT	10S	2687	2954	267	10%
CCT	10A	435	420	-15	-3%
CCT	10B	228	250	22	10%
CCT	15	674	715	41	6%
CCT	-15	383	445	62	16%
CCT	20N	556	725	169	30%
CCT	20S	950	1053	103	11%
CCT	25N	410	421	11	3%
CCT	25S	412	491	79	19%
CCT	30	1414	1526	112	8%
CCT	30	1132	1180	48	4%
CCT	40	254	297	43	17%
CCT	40	171	221	50	29%
CCT	45	155	159	4	3%
CCT	-45	75	96	21	28%
CCT	50	1018	1066	48	5%
CCT	50	665	703	38	6%
CCT	CMBRLND		414		
GCT	10A	1213	1305	92	8%
GCT	10B	1805	2142	337	19%
GCT	20	1159	1291	132	11%
GCT	20	931	1031	100	11%
GCT	30	742	899	157	21%
GCT	30	736	812	76	10%
GCT	35A	813	904	91	11%
GCT	35B	956	1138	182	19%
GCT	40A	1473	1713	240	16%
GCT	40B	1135	1291	156	14%
HAT 1	N	66	75	9	14%
HAT 1	S	48	56	8	17%
HAT 1	S-	80	101	21	26%
HAT 3	A	192	214	22	11%
HAT 3	B	163	174	11	7%
HAT 4	0	151	171	20	13%
HAT 4	-	149	159	10	7%
HAT 5	0	139	151	12	9%
HAT 5	-	157	178	21	13%
HAT 6	0	102	107	5	5%
HAT 6	-	35	37	2	6%

Table 43 continued

ATLANTIC STN		127	128	1	1%
ATLANTIC STN-		99	109	10	10%
AUC A	0	307	339	32	10%
AUC B	0	149	162	13	9%
BUC	BLUE	173	187	14	8%
BUC	BLUE-	390	421	31	8%
BUC	RED	12	14	2	17%
BUC	RED-	89	89	0	0%
EMORY	A	28	30	2	7%
EMORY	A-	80	87	7	9%
EMORY	B	143	148	5	3%
EMORY	C	237	264	27	11%
EMORY	C-	31	32	1	3%
EMORY	CCTMA	1053	1275	222	21%
EMORY	CCTMA-	119	134	15	13%
EMORY	D	187	204	17	9%
EMORY	E	101	113	12	12%
EMORY	E-	13	14	1	8%
EMORY	EUHM A	0	0	0	
EMORY	EUHM B	0	0	0	
EMORY	EXPARK	17	19	2	12%
EMORY	EXPARK-	53	58	5	9%
EMORY	GRADY	4	4	0	0%
EMORY	GRADY-	0	0	0	
EMORY	LOOP	94	105	11	12%
EMORY	M	2	2	0	0%
EMORY	M-	1	1	0	0%
EMORY	NDEK	1366	1383	17	1%
EMORY	NDEK-	146	149	3	2%
EMORY	SDEK	516	530	14	3%
EMORY	SDEK-	58	62	4	7%
EMORY	VA	39	45	6	15%
EMORY	VA-	5	5	0	0%
KSU	BLACK	240	309	69	29%
KSU	BLUE	198	227	29	15%
KSU	GOLD	3	4	1	33%
KSU	GOLD-	13	20	7	54%
KSU	GREEN	84	103	19	23%
TECH	TROLLEY	214	189	-25	-12%
TECH	TROLLEY-	43	47	4	9%
TECH	BLUE	188	213	25	13%
TECH	GREEN	132	153	21	16%

Table 43 continued

TECH	RED	339	368	29	9%
TECH	EMORY	33	35	2	6%
TECH	EMORY-	15	18	3	20%
STATE	BLUE	1816	1648	-168	-9%
STATE	GREEN	41	55	14	34%
STATE	RED	0	0	0	
WESTGA	APT	35	37	2	6%
WESTGA	APT-	28	30	2	7%
WESTGA	BLUE	11	13	2	18%
WESTGA	RED	30	29	-1	-3%
WESTGA	GREY	41	42	1	2%
WESTGA	GREY-	36	38	2	6%

Table 44: Local Bus Boardings - 2020 Base to Stage 1

Agency	Route	2020 Base	2020 Stage 1	Absolute Change	Percent Change
MARTA	1A	730	1423	693	95%
MARTA	1B	525	835	310	59%
MARTA	2	514	560	46	9%
MARTA	-2	490	506	16	3%
MARTA	2S		891		
MARTA	2S-		851		
MARTA	3A	10	13	3	30%
MARTA	3B	40	23	-17	-43%
MARTA	4A	188	248	60	32%
MARTA	4B	322	275	-47	-15%
MARTA	5	1636	1961	325	20%
MARTA	-5	1808	2213	405	22%
MARTA	6	1089	1119	30	3%
MARTA	-6	1662	1724	62	4%
MARTA	6S	794	796	2	0%
MARTA	6S-	1436	1451	15	1%
MARTA	8	227	158	-69	-30%
MARTA	-8	184	146	-38	-21%
MARTA	9	237	196	-41	-17%
MARTA	-9	632	440	-192	-30%
MARTA	12	674	713	39	6%
MARTA	-12	678	562	-116	-17%
MARTA	12S	518	952	434	84%
MARTA	12S-	540	930	390	72%

Table 44 continued

MARTA	13	34	47	13	38%
MARTA	-13	100	108	8	8%
MARTA	15A	924	932	8	1%
MARTA	15B	348	341	-7	-2%
MARTA	15C A	538	542	4	1%
MARTA	15C B	285	274	-11	-4%
MARTA	16A	786	743	-43	-5%
MARTA	16B	533	530	-3	-1%
MARTA	19	831	784	-47	-6%
MARTA	-19	733	694	-39	-5%
MARTA	21A	769	990	221	29%
MARTA	21B	570	1065	495	87%
MARTA	24	35	34	-1	-3%
MARTA	-24	81	29	-52	-64%
MARTA	25A	109	109	0	0%
MARTA	25A-	76	77	1	1%
MARTA	25B	164	159	-5	-3%
MARTA	25B-	164	170	6	4%
MARTA	26	329	158	-171	-52%
MARTA	-26	279	177	-102	-37%
MARTA	27A	660	653	-7	-1%
MARTA	27B	523	524	1	0%
MARTA	30A	289	286	-3	-1%
MARTA	30B	534	533	-1	0%
MARTA	32A	520	528	8	2%
MARTA	32B	1162	1128	-34	-3%
MARTA	33A	103	99	-4	-4%
MARTA	33B	68	68	0	0%
MARTA	34	163	139	-24	-15%
MARTA	-34	500	387	-113	-23%
MARTA	36	114	100	-14	-12%
MARTA	-36	170	153	-17	-10%
MARTA	37A	174	38	-136	-78%
MARTA	37B	351	132	-219	-62%
MARTA	39A	1543	1720	177	11%
MARTA	39B	1921	2098	177	9%
MARTA	42A	304	251	-53	-17%
MARTA	42B	377	340	-37	-10%
MARTA	47N	450	455	5	1%
MARTA	47S	323	322	-1	0%
MARTA	49A	615	626	11	2%
MARTA	49B	1128	984	-144	-13%

Table 44 continued

MARTA	50	37	37	0	0%
MARTA	-50	29	38	9	31%
MARTA	51A	160	138	-22	-14%
MARTA	51B	418	279	-139	-33%
MARTA	53	4	10	6	150%
MARTA	-53	5	11	6	120%
MARTA	55A	1043	1176	133	13%
MARTA	55B	1833	2365	532	29%
MARTA	56	133	132	-1	-1%
MARTA	-56	101	100	-1	-1%
MARTA	58	214	217	3	1%
MARTA	-58	157	161	4	3%
MARTA	60	293	233	-60	-20%
MARTA	-60	762	717	-45	-6%
MARTA	64		4		
MARTA	-64		57		
MARTA	66	72	70	-2	-3%
MARTA	-66	110	109	-1	-1%
MARTA	67A	30	29	-1	-3%
MARTA	67B	44	44	0	0%
MARTA	68	13	66	53	408%
MARTA	-68	126	140	14	11%
MARTA	71	767	765	-2	0%
MARTA	-71	2039	2029	-10	0%
MARTA	73A	1299	1300	1	0%
MARTA	73B	564	569	5	1%
MARTA	74A	288	198	-90	-31%
MARTA	74B	484	509	25	5%
MARTA	75	1096	1145	49	4%
MARTA	-75	886	895	9	1%
MARTA	78A	273	371	98	36%
MARTA	78B	595	896	301	51%
MARTA	81	18	20	2	11%
MARTA	-81	11	12	1	9%
MARTA	82	103			
MARTA	-82	253			
MARTA	83	539	540	1	0%
MARTA	-83	1561	1619	58	4%
MARTA	84	475	319	-156	-33%
MARTA	-84	775	428	-347	-45%
MARTA	85A	769	728	-41	-5%
MARTA	85B	400	434	34	9%

Table 44 continued

MARTA	86	440	486	46	10%
MARTA	-86	895	1044	149	17%
MARTA	87	767	714	-53	-7%
MARTA	-87	1034	1019	-15	-1%
MARTA	89	755	147	-608	-81%
MARTA	-89	1111	285	-826	-74%
MARTA	93A	42	54	12	29%
MARTA	93B	39	31	-8	-21%
MARTA	95	2403	2299	-104	-4%
MARTA	-95	1249	1939	690	55%
MARTA	99A	29	23	-6	-21%
MARTA	99A-	38	32	-6	-16%
MARTA	99B	21	15	-6	-29%
MARTA	99B-	22	14	-8	-36%
MARTA	102	499			
MARTA	-102	567			
MARTA	103A	260	273	13	5%
MARTA	103B	265	297	32	12%
MARTA	104A	47	48	1	2%
MARTA	104B	192	194	2	1%
MARTA	107	603	1564	961	159%
MARTA	-107	1677	2098	421	25%
MARTA	110	908	924	16	2%
MARTA	-110	1029	1013	-16	-2%
MARTA	110A	867	878	11	1%
MARTA	110A-	868	847	-21	-2%
MARTA	111	236	22	-214	-91%
MARTA	-111	606	16	-590	-97%
MARTA	114	351	303	-48	-14%
MARTA	-114	346	342	-4	-1%
MARTA	115	412	264	-148	-36%
MARTA	-115	1827	960	-867	-47%
MARTA	115S		120		
MARTA	115S-		630		
MARTA	116	380	255	-125	-33%
MARTA	-116	1364	859	-505	-37%
MARTA	116S		85		
MARTA	116S-		623		
MARTA	117	386	815	429	111%
MARTA	-117	1196	1537	341	29%
MARTA	119	39	69	30	77%
MARTA	-119	120	124	4	3%

Table 44 continued

MARTA	120	1506	1507	1	0%
MARTA	-120	2078	2117	39	2%
MARTA	121	1007	1148	141	14%
MARTA	-121	1832	1872	40	2%
MARTA	123	37	38	1	3%
MARTA	-123	70	83	13	19%
MARTA	124	732	734	2	0%
MARTA	-124	1176	1190	14	1%
MARTA	125A	990	803	-187	-19%
MARTA	125B	787	553	-234	-30%
MARTA	126A	348	351	3	1%
MARTA	126B	428	433	5	1%
MARTA	132	579	583	4	1%
MARTA	-132	537	542	5	1%
MARTA	148A	271			
MARTA	148B	140			
MARTA	150	132	164	32	24%
MARTA	-150	263	356	93	35%
MARTA	153A	318	318	0	0%
MARTA	153B	59	59	0	0%
MARTA	155A	17			
MARTA	155B	26			
MARTA	162	276	282	6	2%
MARTA	-162	694	768	74	11%
MARTA	165	284	283	-1	0%
MARTA	-165	617	620	3	0%
MARTA	170	15	15	0	0%
MARTA	-170	15	15	0	0%
MARTA	172A	59			
MARTA	172B	93			
MARTA	178A	399	506	107	27%
MARTA	178B	491	250	-241	-49%
MARTA	180A	464	492	28	6%
MARTA	180B	724	823	99	14%
MARTA	180S A	222			
MARTA	180S B	379			
MARTA	181A	192	545	353	184%
MARTA	181B	243	525	282	116%
MARTA	183A	76	78	2	3%
MARTA	183B	40	45	5	13%
MARTA	185A	364	389	25	7%
MARTA	185B	669	586	-83	-12%

Table 44 continued

MARTA	186A	960	839	-121	-13%
MARTA	186B	257	239	-18	-7%
MARTA	189	171	565	394	230%
MARTA	-189	522	1010	488	93%
MARTA	191A	612	601	-11	-2%
MARTA	191B	184	185	1	1%
MARTA	192	1542	1407	-135	-9%
MARTA	-192	997	989	-8	-1%
MARTA	193	284	291	7	2%
MARTA	-193	203	207	4	2%
MARTA	193S	71	64	-7	-10%
MARTA	193S-	63	59	-4	-6%
MARTA	194A	384	397	13	3%
MARTA	194B	170	179	9	5%
MARTA	195A	227	222	-5	-2%
MARTA	195B	230	219	-11	-5%
MARTA	196A	1336	1426	90	7%
MARTA	196B	688	673	-15	-2%
MARTA	197A	145	139	-6	-4%
MARTA	197B	137	139	2	1%
MARTA	198	103	111	8	8%
MARTA	-198	69	69	0	0%
MARTA	221A	638	811	173	27%
MARTA	221B	197	227	30	15%
CCT	10N	3140	3172	32	1%
CCT	10S	2954	2952	-2	0%
CCT	10A	420	440	20	5%
CCT	10B	250	263	13	5%
CCT	15	715	711	-4	-1%
CCT	-15	445	439	-6	-1%
CCT	20N	725	725	0	0%
CCT	20S	1053	1058	5	0%
CCT	25N	421	418	-3	-1%
CCT	25S	491	491	0	0%
CCT	30	1526	1518	-8	-1%
CCT	30	1180	1172	-8	-1%
CCT	40	297	312	15	5%
CCT	40	221	232	11	5%
CCT	45	159	161	2	1%
CCT	-45	96	116	20	21%
CCT	50	1066	1062	-4	0%
CCT	50	703	699	-4	-1%

Table 44 continued

CCT	CMBRLND	414	418	4	1%
GCT	10A	1305	1335	30	2%
GCT	10B	2142	2131	-11	-1%
GCT	20	1291	1292	1	0%
GCT	20	1031	1035	4	0%
GCT	30	899	898	-1	0%
GCT	30	812	812	0	0%
GCT	35A	904	988	84	9%
GCT	35B	1138	1130	-8	-1%
GCT	40A	1713	1733	20	1%
GCT	40B	1291	1308	17	1%
HAT 1	N	75	75	0	0%
HAT 1	S	56	56	0	0%
HAT 1	S-	101	101	0	0%
HAT 3	A	214	214	0	0%
HAT 3	B	174	173	-1	-1%
HAT 4	0	171	172	1	1%
HAT 4	-	159	159	0	0%
HAT 5	0	151	151	0	0%
HAT 5	-	178	178	0	0%
HAT 6	0	107	107	0	0%
HAT 6	-	37	37	0	0%
ATLANTIC STN		128	28	-100	-78%
ATLANTIC STN-		109	105	-4	-4%
AUC A	0	339	340	1	0%
AUC B	0	162	158	-4	-2%
BUC	BLUE	187	182	-5	-3%
BUC	BLUE-	421	381	-40	-10%
BUC	RED	14	13	-1	-7%
BUC	RED-	89	68	-21	-24%
EMORY	A	30	27	-3	-10%
EMORY	A-	87	88	1	1%
EMORY	B	148	149	1	1%
EMORY	C	264	269	5	2%
EMORY	C-	32	32	0	0%
EMORY	CCTMA	1275	1251	-24	-2%
EMORY	CCTMA-	134	99	-35	-26%
EMORY	D	204	207	3	1%
EMORY	E	113	114	1	1%
EMORY	E-	14	14	0	0%
EMORY	EUHM A	0	0	0	
EMORY	EUHM B	0	0	0	

Table 44 continued

EMORY	EXPARK	19	17	-2	-11%
EMORY	EXPARK-	58	58	0	0%
EMORY	GRADY	4	0	-4	-100%
EMORY	GRADY-	0	0	0	
EMORY	LOOP	105	104	-1	-1%
EMORY	M	2	2	0	0%
EMORY	M-	1	1	0	0%
EMORY	NDEK	1383	1400	17	1%
EMORY	NDEK-	149	150	1	1%
EMORY	SDEK	530	519	-11	-2%
EMORY	SDEK-	62	56	-6	-10%
EMORY	VA	45	45	0	0%
EMORY	VA-	5	5	0	0%
KSU	BLACK	309	300	-9	-3%
KSU	BLUE	227	227	0	0%
KSU	GOLD	4	4	0	0%
KSU	GOLD-	20	20	0	0%
KSU	GREEN	103	103	0	0%
TECH	TROLLEY	189	148	-41	-22%
TECH	TROLLEY-	47	42	-5	-11%
TECH	BLUE	213	138	-75	-35%
TECH	GREEN	153	136	-17	-11%
TECH	RED	368	104	-264	-72%
TECH	EMORY	35	35	0	0%
TECH	EMORY-	18	15	-3	-17%
STATE	BLUE	1648	1522	-126	-8%
STATE	GREEN	55	86	31	56%
STATE	RED	0	4	4	
WESTGA	APT	37	37	0	0%
WESTGA	APT-	30	30	0	0%
WESTGA	BLUE	13	13	0	0%
WESTGA	RED	29	29	0	0%
WESTGA	GREY	42	42	0	0%
WESTGA	GREY-	38	38	0	0%

APPENDIX E

DETAILED PLAN FOR THE EXPERIMENTAL SCENARIO

Corridor-Level Changes

North Quadrant

I-75 NW

Inbound

- On some inbound express bus routes, add intermediate stops and frequency.
    - CCT 102 (Acworth to Midtown)
        - Stops: Town Center, Marietta (Roswell Rd), Cumberland north (Terrell Mill Rd), and Cumberland south (Cumberland Blvd).
            - Town Center stop involves deviation. Marietta and Cumberland stops occur and freeway interchange.
        - Frequency increase to 22 daily runs
    - GRTA 482 (Town Center to Perimeter Center)
        - Stops: Marietta (Roswell Rd), Cumberland north (Terrell Mill Rd), and Cumberland east (Northside and New Northside Dr).
        - Extend to Sugarloaf Mills, as described under I-85 NE.
            - In Perimeter Center, route would follow reverse direction of GRTA 417. It would no longer stop at Sandy Springs station.
        - Frequency increase to 14 daily runs.
    - GRTA 490 (Canton to Downtown)
        - Existing stops: Woodstock, Town Center
        - Added stops: Marietta (Roswell Rd), Cumberland north (Terrell Mill Rd), and Cumberland south (Cumberland Blvd).

        - Frequency increase to 13 daily runs[25].
- Some inbound express routes would not have any intermediate stops nor frequency added.
    - GRTA 480 (Acworth to Downtown)
    - CCT 100 (Town Center to Downtown)
    - GRTA 483 (Woodstock to Midtown)
- For the CCT 101 (Marietta to Downtown), repurpose it to two frequent local bus routes connecting P&R lots in the Marietta area to I-75 mainline express buses.
    - A new P&R lot would be created east of I-75 along Roswell Road to provide connectivity for East Cobb travelers.
    - The two routes would span the existing Marietta Transfer Center P&R lot to the new East Cobb P&R lot.
    - One route, the CCT 101-S, would connect P&R lots to the Roswell Road express lane interchange. This would be to connect to inbound express buses.
    - The other route, the CCT 101-N, would connect P&R lots to the North Marietta Pkwy interchange. This would be to connect to outbound express buses to Town Center.

Outbound

- Restructure the reverse commute CCT 10A, 10B, and 10C routes
    - The 10A and 10B would be truncated to serve just the local Cumberland area. They would be enhanced in this area, such that the routes become two-way, the frequency increases, and the routes would have increased coverage.
    - On the 10C, add intermediate stops at Cumberland south (Cumberland Blvd), Cumberland north (Windy Hill Rd), and Marietta (North Marietta Pkwy). The 10A and 10B would provide last-mile connectivity in the Cumberland area.
    - Increase the frequency of the 10C such that it runs every 30 minutes.
    - From Arts Center Station, the 10C would proceed through Atlantic Station, making local stops, and then enter I-75 via the Northside Drive HOV exit.

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[25] This is an increase from 7 daily runs. To reiterate, even though in Phase 1, there really would be 8 daily runs, not all runs would extend to Canton. This complexity was taken into account by subtracting one daily run.

        - This idea is adapted from GRTA's Phase 1 PM routing for route 483 (Nelson\Nygaard, 2015f).
- Extend the GRTA 410 and GRTA 417 from Lindbergh Center and Perimeter Center, respectively, to Town Center
    - Both routes would stop at Cumberland north (Windy Hill Rd) and Marietta (N. Marietta Pkwy).
    - GRTA 410
        - From Lindbergh Center Station, route would take the following path: Piedmont Rd → Piedmont Cir → Monroe Dr → Armour Dr → GA-13 → I-85 → I-75. Local stops would be made along the way.
        - Added stop at Cumberland south (Cumberland Blvd)
    - GRTA 417
        - Added stop at Cumberland east (Northside and New Northside Drives).

<u>GA-400 N</u>

GRTA 400 and 401

- Route GRTA 400 (Cumming to Downtown) to stop in Perimeter Center, along with the 401. The 400 would continue to Downtown, while the 401 would terminate in this center.
- The routing of the GRTA 400 and 401 in Perimeter Center would be more streamlined than the Horizon 1 GRTA 401. This is to mitigate the effects of the GRTA 400 stopping in this center. The only MARTA station that would be served directly is Medical Center.
    - The stations Sandy Springs and Dunwoody would no longer be served directly by express bus. However, those two stations, as well as local stops along the Horizon 1 GRTA 401 route, would be served by new two-way circulator to which riders can transfer. (Needless to say, riders could also transfer to the MARTA rail directly!)
    - The GRTA 400 and 401 routes would exit from GA-400 onto Hammond Drive and proceed to Medical Center Station, making local stops along the way. The GRTA 401 would end there, while the GRTA 400 would continue to proceed toward Downtown, taking Peachtree-Dunwoody Road to the Glenridge Connector to GA-400, making local stops along the way.
- The GRTA 400 would make two additional intermediate stops: at Windward Parkway and Mansell Road (North Point). The GRTA 401 would remain nonstop.
    - The Windward Parkway stop would occur directly where the freeway ramp meets the road. Riders can transfer to and from local bus. The express bus would then proceed straight to get back on the freeway.

    - The Mansell Road stop, going southbound, would be at the Mansell Road P&R lot, which is nested in the interchange. The northbound evening runs were not coded in the model due to the model's design (as explained in Appendix A). There would be a choice between making these runs also stop directly at the P&R lot, which would involve a deviation and left turns, or to allow them to stop where the freeway ramp meets Mansell Road.
- The headway of the GRTA 400 is reduced to 34 minutes, as eight more daily runs would be added to "compensate" existing riders for intermediate stops. The frequency of the GRTA 401 would stay the same.

MARTA 240

- This route would be rerouted such that it goes to Perimeter Center instead of North Springs Station. It would follow the GRTA 401 routing and end at Medical Center Station.
- The frequency would be unchanged from Phase 1.

MARTA 140, 242 and 243

- During peak hour, the 140 would be truncated to serve only its local portion.
    - Headways would be halved from 15 to 30 minutes.
    - The local portion would be the same as in MARTA's Phase 1, as described in Appendix B. The MARTA 243 would serve the GA-400 portion, providing a connection to this route at Mansell Road.
    - During off-peak hours, the 140 would remain the same as in Phase 1, keeping its GA-400 portion. This is because the trunk 243 route is peak only.
- The 242 would be substantially modified.
    - First, it would be truncated such that it would no longer run on the GA-400 freeway. It would continue to serve the local road portion from GA-400 to the west side of the Windward employment center. In the model, it is converted from express bus to local bus. The headway would be halved from 30 to 15.
    - Second, this truncated local route would be extended south to Mansell Road via local roads. It would be converted to two-way. It would go to the Windward P&R lot, proceed south on North Point Parkway and then east on GA-120 to the GSU Alpharetta Center, then head back west on GA-120 to Westside Parkway. It then would proceed south on Westside Parkway to Mansell Road, then east to the road's terminus with Haynes Bridge Road. It would stop at the Mansell Road P&R lot along the way.
- The 243 route would serve as the GA-400 "trunk route" for reverse commutes to Alpharetta.

    - Local routing in the Windward center would stay the same.
    - A stop on the Windward Parkway freeway ramp, though, would be added. Riders can transfer to the 242 to access the west part of Windward and other parts of Windward and North Point.
    - An intermediate stop would be added at Mansell. Going northbound, the route would *not* deviate to the Mansell P&R lot. Instead, it would stop on the Mansell Road freeway ramp and then proceed straight to get back on GA-400.
    - The origin of the route would be extended south to Medical Center Station along Peachtree-Dunwoody Road. The route would make local stops on this road. This change would enhance the role of Medical Center Station as a transfer hub for riders bound to suburban employment centers. It also would increase circulation within Perimeter Center.
    - The headway would be halved from 30 to 15.

MARTA 85 and 185

- Extend both routes south to Medical Center Station along Peachtree-Dunwoody Road. Doing so would enhance connectivity to Roswell / Alpharetta and also provide local circulation within Perimeter Center. The extension would follow the same path as the MARTA 243 (between North Springs and Medical Center stations).

<u>GA-141 N</u>

- Reroute the GRTA 408 in Doraville area such that, going south, it stays on GA-141 until reaching Motors Industrial Way, which occurs immediately after GA-141's interchange with I-285. The bus then would proceed east on Motors Industrial Way, stopping right outside of Doraville Station, and then ending in the Doraville Station bus bay.
    - This change would provide connectivity to other express buses, which would be rerouted to stop on Motors Industrial Way. Details are explained later in this appendix.
    - Construction changes are recommended to provide easy access between Motors Industrial Way and the Doraville MARTA station.
- Increase the frequency of the GRTA 408 in each direction to 8 runs per day, to account for increased connectivity between other express buses. This frequency is modeled as 60 minute headways.
- Repurpose the GCT 102 to a crosstown peak-hour local bus running between Peachtree Corners (along GA-141) and the Indian Trail P&R lot.

I-85 NE

Inbound

- For inbound express buses, maintain some as non-stop while adding intermediate stops to others.
    - Stops are added to the following buses
        - GRTA 410 (Sugarloaf Mills to Lindbergh)
            - Stops: Indian Trail, Chamblee-Tucker Road, Clairmont Road.
                - Note: due to low frequency of connecting local bus, the GRTA 410 is the only inbound bus for which the Chamblee-Tucker stop is proposed.
            - Frequency increased to 14 runs per day.
            - Local stops added in the Lindbergh area.
        - GRTA 414 (Hamilton Mills to Midtown)
            - Existing Stage 1 stops: Mall of Georgia, Sugarloaf Mills
            - Added stops: Indian Trail, Clairmont Road.
            - Increase frequency to 11 runs per day
        - GRTA 416 (Dacula to Downtown)
            - Stops: Sugarloaf Parkway, Indian Trail, Clairmont Road.
                - Note: This bus would *not* stop at either Sugarloaf Mills P&R lot. Instead, it would stop on the Sugarloaf Parkway interchange with GA-316, to which riders can connect to and from local and other express bus.
            - Frequency increased to 18 runs per day.
        - GRTA 417 (Sugarloaf Mills to Perimeter Center)
            - Stops: Indian Trail, Doraville.
                - Doraville stop would be on Motors Industrial Way.
            - Frequency increased to 12 runs per day.
    - The following buses would have no added intermediate stops and keep the same frequency
        - GCT 101 (Mall of GA to Downtown)
        - GCT 103 (Sugarloaf Mills to Downtown)
            - Note: Immediately before entering the GA-316 freeway, a local stop is added at the interchange with Sugarloaf Parkway. This would allow riders from Dacula to transfer from the GRTA 416 if they wish to have a non-stop ride to Downtown.

        - GRTA 411 (Hamilton Mills to Midtown)
        - GRTA 412 (Sugarloaf Mills to Midtown)
        - GRTA 413 (Hamilton Mills to Downtown)
- Repurpose the GCT 102 (Indian Trail to Downtown) as a two-way, peak-hour, local crosstown route between Indian Trail and Peachtree Corners, using Brook Hollow Pkwy, Jimmy Carter Blvd, and Holcomb Bridge Road.
    - Current Indian Trail riders to Downtown would use the GRTA 416.
    - Frequency would increase to 16 daily runs in each direction.
- Extend the GRTA 410 and GRTA 417 from their termini, at Town Center and Perimeter Center, respectively, to Town Center along the I-75 NW corridor. Details are described under I-75 NW.

Outbound

- Outbound express buses would stop at all identified intermediate stops.
    - GCT 103A (Downtown to Sugarloaf Mills)
        - Stops: Lindbergh Center Station, Clairmont Road, Chamblee-Tucker Road, Indian Trail
            - The bus would travel to Lindbergh via GA-13, Monroe Dr, Piedmont Circle, and Piedmont Rd, making local stops along the way. It would exit the Lindbergh area via the HOV exit from Lindbergh Dr to I-85 North, again making local stops on the way to the exit.
            - At Indian Trail, rather than deviate to the P&R lot, the bus would stop where the freeway ramp meets Indian Trail, then immediately return to the freeway.
        - Frequency would increase to 15 runs per day.
    - GRTA 482 (Town Center to Perimeter Center to Sugarloaf Mills)
        - Route would be extended from Perimeter Center to Sugarloaf Mills.
        - Stops: Doraville, Indian Trail.
            - Doraville stop would be on Motors Industrial Way.
            - Indian Trail stop would be like with GCT 103A

East Quadrant

- For GRTA routes 419 (Snellville to Downtown) and 428 (West Conyers to Perimeter Center), add intermediate stop at the interchange if Memorial Drive and I-285

    - Riders can connect to the peak-hour limited-stop MARTA 221. This route, which currently ends at Kensington Station (MARTA, n.d.-a), can be extended to serve the Clifton Corridor.
    - Riders would also have access to the MARTA Blue Line at Kensington station.
- To serve identified market from Hewatt Rd to Perimeter Center, add new route, which the author calls the GRTA 500. It would run on US-78 and I-285.
    - Routing in Perimeter Center would be the same as the GRTA 428.
- Both Perimeter-bound routes (GRTA 428 and 500) would make the following additional intermediate stops:
    - Lavista Rd – to serve the Northlake Mall area.
    - Doraville – stop would be on Motors Industrial Way.
- Express bus frequencies would be as follows:
    - GRTA 419 – 22 daily runs
    - GRTA 428 – 16 daily runs
    - GRTA 500 – 12 daily runs

South Quadrant

- Some express routes would stop at the Airport
    - Some express bus routes on the I-75 SE and US-41 corridors would stop near the Airport's International Terminal on the Charles W. Grant Pkwy HOV interchange. Frequency would increase as a result
        - GRTA 430 (McDonough to Downtown) – 17 daily runs
        - GRTA 431 (Stockbridge to Midtown) – 16 daily runs
        - GRTA 440 (Hampton to Downtown/Midtown) – 17 daily runs
    - Some express routes on those two corridors would not make the Airport stop
        - GRTA 432 (Stockbridge to Downtown)
        - GRTA 441 (Jonesboro to Downtown/Midtown)
    - From the I-85 SW corridor, the GRTA 453 would stop directly at the Domestic Terminal. The frequency would increase to 21 daily runs.
- Discontinue the GRTA 442 (Riverdale to Downtown)
    - Instead, increase the peak period frequency on the MARTA 196 from every 30 minutes to every 15 minutes. This bus would connect riders from the Riverdale P&R lot to the GRTA 440 and 441 buses.
- Local stops on the GRTA 440 and 441 buses are added.
    - Stops: Mt. Zion Rd. and Upper Riverdale Rd.
    - These stops would provide connectivity to and from local MARTA buses. MARTA buses would take passengers to the Southlake Mall employment center.

    - Frequency is added to the GRTA 440, as noted above, and also to the 441. The 441 frequency is increased to 14 daily runs.
    - The reverse commute GRTA 441R bus is modified.
        - Route would run through both Downtown and Midtown before proceeding south onto the freeway.
        - Route would stop near the Airport on the Charles W. Grant Pkwy HOV interchange.
        - Route also would make local stops at Upper Riverdale and Mount Zion Roads.
        - Frequency would increase from five to nine daily runs.

West Quadrant

- GRTA 463 and 476 (to Downtown/Midtown from West Douglas and Hiram, respectively) – additional stop at Fulton Industrial Blvd.
    - Riders who work in that area can transfer to the MARTA bus that runs down corridor.
- CCT 30 – add Fulton Industrial stop as well.
    - Would provide access both to Six Flags Over Georgia and to the MARTA Blue Line at HE Holmes Station.
    - Peak-hour headway reduced to 14 minutes
- CCT 25
    - This route was in the model given to the author, though it did not appear in the CCT system map (CCT, 2015b). It follows a similar path to the CCT 30 along I-20. The author did not notice this route in the model until after the first three scenarios had been run. For consistency, the CCT 25 was kept in the Experimental Scenario. The Fulton Industrial stop was added.
    - Peak-hour headway reduced to 48 minutes.
- Revive the GRTA 475, which is planned to be dropped in Horizon 1, but repurpose it to connect to Perimeter Center instead of Downtown. The route, like before, would begin at Mableton.
    - Route would go through Fulton Industrial and stop at the interchange of Fulton Industrial Blvd. and I-20. This would be a hub point for other express bus routes. Then the route would proceed to Perimeter Center.
    - Other intermediate stops: Cumberland west (Cobb Pkwy) and Cumberland east (Northside and New Northside Drives).
    - Routing in Perimeter Center would parallel the GRTA 482, except that the route would not extend beyond this center. It would end at Dunwoody Station.

Employment Center Changes

I-75 NW Centers

Town Center

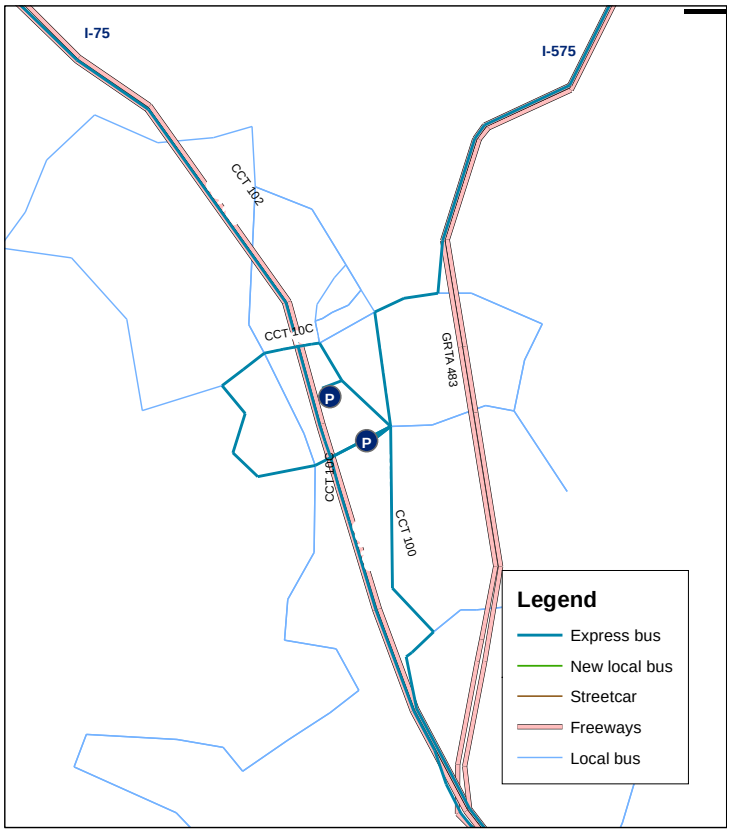

Figure 24: Town Center

In Horizon 1, GRTA plans to have all of its passing express buses make an intermediate stop in this area – at the Big Shanty P&R lot. These buses come from Acworth and Woodstock. CCT, though, also has an express bus from Acworth that passes this area – the 102. In this scenario, it is proposed that this bus stop in Town Center as well, following the same path as the GRTA 480. Furthermore, the CCT 100, while

continuing to begin at the nearby Busbee P&R lot, would also stop just outside of the Big Shanty P&R lot to enhance connectivity with other express buses.

There are two local buses in the area – the CCT 40 and CCT 45. To improve connectivity with these buses, local stops would be added to some express bus routes. For example, the GRTA 480 and CCT 102 would stop on the Big Shanty Rd. interchange, so that passengers can walk to the CCT 45. The GRTA 483 and 490 would stop where Chastain Rd meets Busbee Pkwy.

The reverse commute bus to the area – the CCT 10C – would be joined with two other outbound buses – the GRTA 410 and GRTA 417. They would follow the path of the 10C to the Town Center at Cobb mall. Then, all three buses would be extended to serve other parts of the employment center. They would continue north on George Busbee Pkwy, go west on Big Shanty Rd to Chastain Rd, then head back east. The bus would stop at Kennesaw State University and at local bus connections. They would end at the Busbee P&R lot.

Marietta

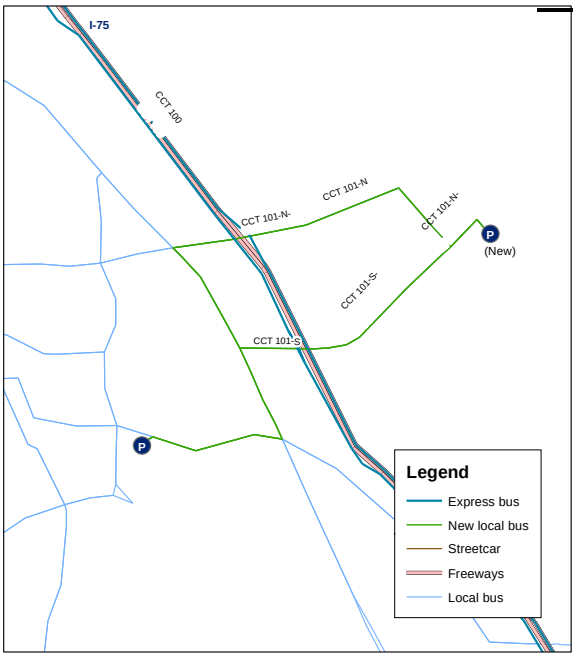

Figure 25: Marietta

For this center, the CCT 101 bus would be repurposed simply to provide local bus connectivity between P&R lots and the other I-75 NW express buses. A new P&R lot would be added along Roswell Road east of I-75 to serve the East Cobb travel demand. There would be two two-way CCT 101 routes, the CCT 101-N and CCT 101-S, that would run between this P&R lot and the Marietta Transfer Center, with 10-minute headways. The S would serve the Roswell Rd. express lane interchange (for inbound commuters), and the N would serve the North Marietta Pkwy general purpose interchange (for commuters to Town Center). Riders would transfer between these routes and express buses at the interchanges.

Cumberland

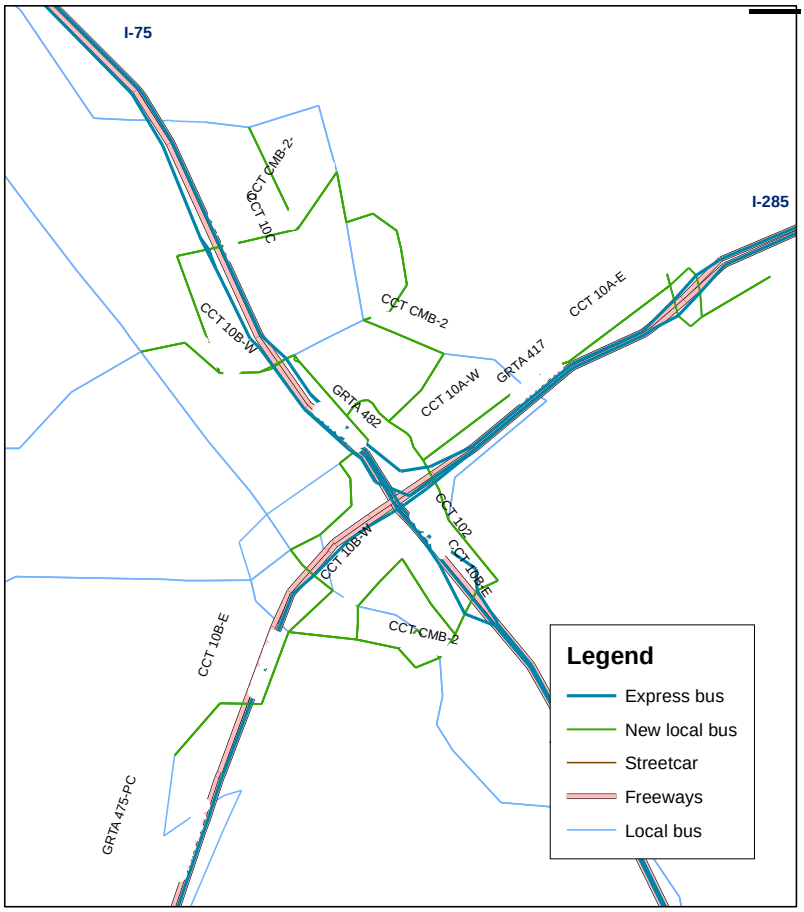

Figure 26: Cumberland

This employment center, sitting at the I-75 and I-285 interchange, is among the more complex to service. In the Experimental Scenario, express buses would stop on four sides of this center, which are referred as Cumberland North, Cumberland East, Cumberland South, and Cumberland West. Cumberland North consists of the Terrell Mill Rd EL and the Windy Hill Rd GP interchanges with I-75. (In the morning, inbound buses on the reversible express lanes would stop on Terrell Mill, while outbound buses in the general purpose lanes would stop at Windy Hill.) Cumberland East is the Northside Dr and New Northside Dr interchange with I-285. This part is actually in Fulton County but is a spillover from Cumberland. Cumberland South is the Cumberland Blvd interchange with I-75. Cumberland West is the Cobb Pkwy interchange with I-285.

Express buses traveling between Town Center and Atlanta would stop on the Cumberland North and Cumberland South interchanges. Those traveling between Town Center and Perimeter Center would stop on the Cumberland North and Cumberland East interchanges. Finally, the GRTA 475 from Mableton to Perimeter Center would stop on the Cumberland West and Cumberland East interchanges.

As discussed earlier, the 10A and 10B buses would be truncated to serve just the local area. Riders from Atlanta would transfer to them via express buses stopping on interchanges. Additionally, the routes would be converted to two-way, and they would undergo some additional changes. The portion of the 10A route from Bentley Rd south to Cobb Parkway would stay the same. However, the route then would be slightly rerouted to go directly south on Cobb Pkwy, then cut through Cumberland Mall to the Cumberland Transfer Center. This change would provide connectivity for those coming from the I-20 West corridor on the GRTA 475. After the Cumberland Transfer Center, the route then would stay on Cumberland Blvd going east, crossing over I-75, and proceeding to where it meets Interstate N Pkwy. Then the bus would head northeast, cross the Chattahoochee River to the spillover in Fulton County, continue on Riveredge Ln, turn left onto Riveredge Pkwy, proceed to the end, and then head back south on

Northside Dr. It then would proceed northeast onto Powers Ferry Rd to the last office building, turn around, and make the return trip. This route would connect to the Cumberland spillover into Fulton County. It would replace part of the MARTA 148, which MARTA plans to cut in Phase 1. There would be an express bus connection to the Northside / New Northside interchange with I-285 in both directions, so local bus may have a greater chance of success in this office area.

For the 10B, a streamlining modification is proposed. Instead of making the Akers Mill deviation, it would stay on Cumberland Blvd. and just proceed north. Employment on the part of Interstate North Parkway that is cut from this route would be served by the 10A. The second modification proposed is an extension southwest of the Cumberland Transfer Center. The route would go south on Cumberland Pkwy and serve the Home Depot call center, as well as additional office employment nearby

To improve the efficiency of local bus routing, it is suggested that the Cumberland Transfer Center be converted to two-way. That is, buses should be allowed to stop on the westbound side of Cumberland Blvd, as well as the eastbound side. In the model, that change is assumed to take place.

Finally, to enhance connectivity between the express bus stops and employment, this thesis proposes a new two-way circulator route. This is in addition to the already-existing proposed circulator route. Beginning at the Terrell Mill Road EL interchange, it would proceed northeast to Powers Ferry Rd, then head southeast on this road, go through an office park area on Wildwood Pkwy and Windy Hill Rd, proceed back on Powers Ferry, head southwest on Windy Ridge Rd, and then southeast on Interstate North Pkwy, which becomes Comberland Blvd. It would take Cumberland Blvd all the way to the Cumberland Transfer Center and then ending at the Cobb Pkwy interchange with I-285. This would be a crescent-shaped route on the eastern side of this employment center, providing connectivity from express bus routes.

GA-400 Centers

Alpharetta (Windward and North Point)

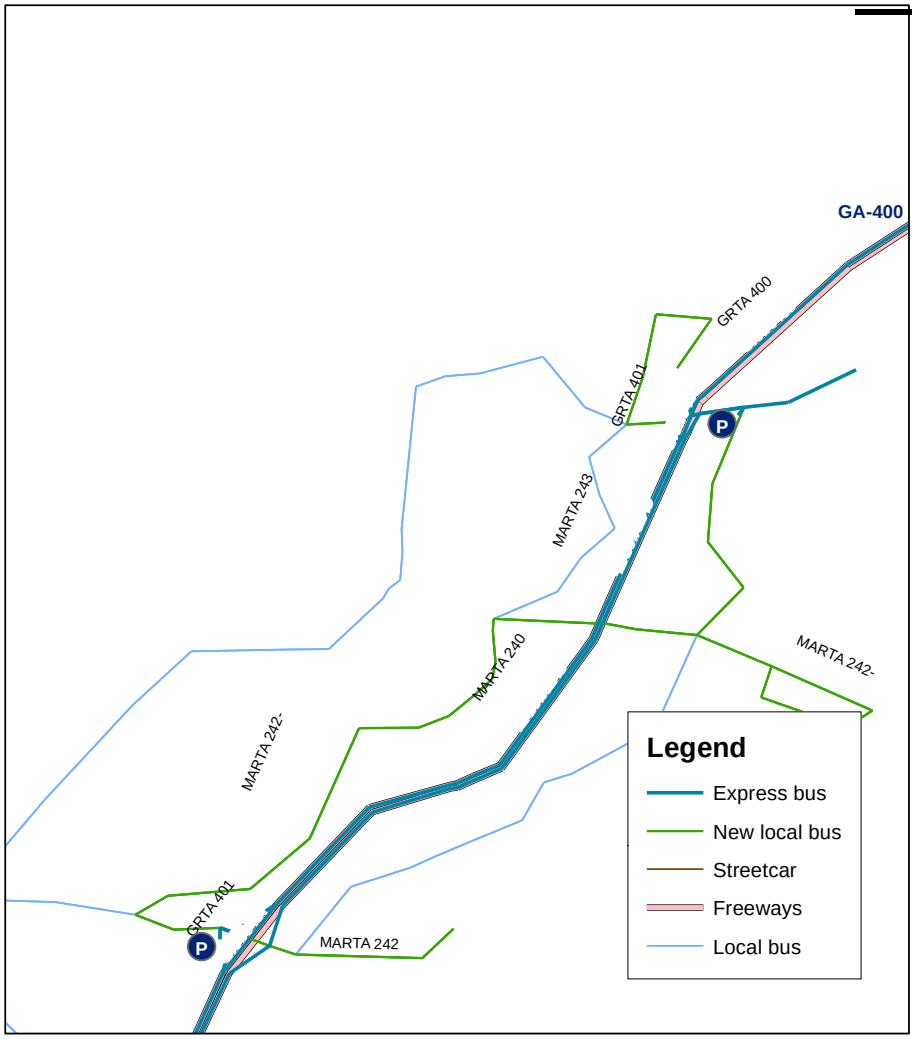

Figure 27: Windward and North Point

These are two adjacent employment centers in Alpharetta on the GA-400 corridor. With two P&R lots, there also are many work trip productions.

In this center, the inbound GRTA 400 would stop at both Windward Parkway and Mansell Road. Alighting riders could transfer to local bus to reach their final destinations. At Windward Parkway, the bus would stop right on the freeway interchange. At Mansell

Rd., the 400 would stop directly at the P&R lot, just like the MARTA 240, as it is nested within the southbound side of the freeway interchange. The GRTA 401 would bypass this area, remaining a nonstop route between Cumming and Perimeter Center.

The outbound MARTA 243 would have a stop added at Mansell Road. However, it would not deviate to its P&R lot, as it is not assumed to be the destinations of the bus riders. At Mansell Rd., the bus would stop on the interchange and get back on the freeway. (Westbound local bus routes leaving from the Mansell P&R lot would be extended slightly to the northbound ramps.) At Windward Parkway, because it is the terminus, the buses will go east and follow its planned Phase 1 path.

During peak hour, the MARTA 140 would be truncated to just serve its local portion, with high frequency. It would run from the Mansell P&R lot to the Windward P&R lot, following its Phase 1 path. The MARTA 242 also would be truncated to serve only the local area. As in Phase 1, it would serve the northwest part of the Windward employment center. Additionally, though, the route would be extended south to cover much of the area from which MARTA plans to cut service on the 140. From the northwest loop of the Windward area, the route would go southeast toward the Windward P&R lot[26], continue south on North Point Pkwy, deviate to the GSU Alpharetta Center, go west on Old Milton Pkwy, then south on Westside Pkwy[27], proceed east on Mansell Road past the P&R lot and GA-400 interchange and end at an office park area at the terminus of Mansell Road.

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[26] The 242 route would stop at the Windward P&R lot going northbound, but southbound, it would not. The northbound version would connect P&R patrons to the inbound GRTA buses; the southbound would connect people coming *off* of the GRTA buses to their jobs.

[27] The portion of Westside Pkwy south of Old Milton Pkwy has the bulk of the office employment that currently is served by the Haynes Bridge Rd version of the MARTA 140, plus additional employment (based on a Google Earth aerial view). The Haynes Bridge version of the 140 is cut in Phase 1.

The other local routes – the MARTA 85 and the 185 – would remain virtually unchanged in this area. The 85 simply would be extended to the east side of the Mansell Rd. interchange with GA-400. Like the 242, the 85 would brush along but not turn into the Mansell P&R lot. Local stops would be added on these routes at the interchanges to facilitate express bus connectivity.

Perimeter Center

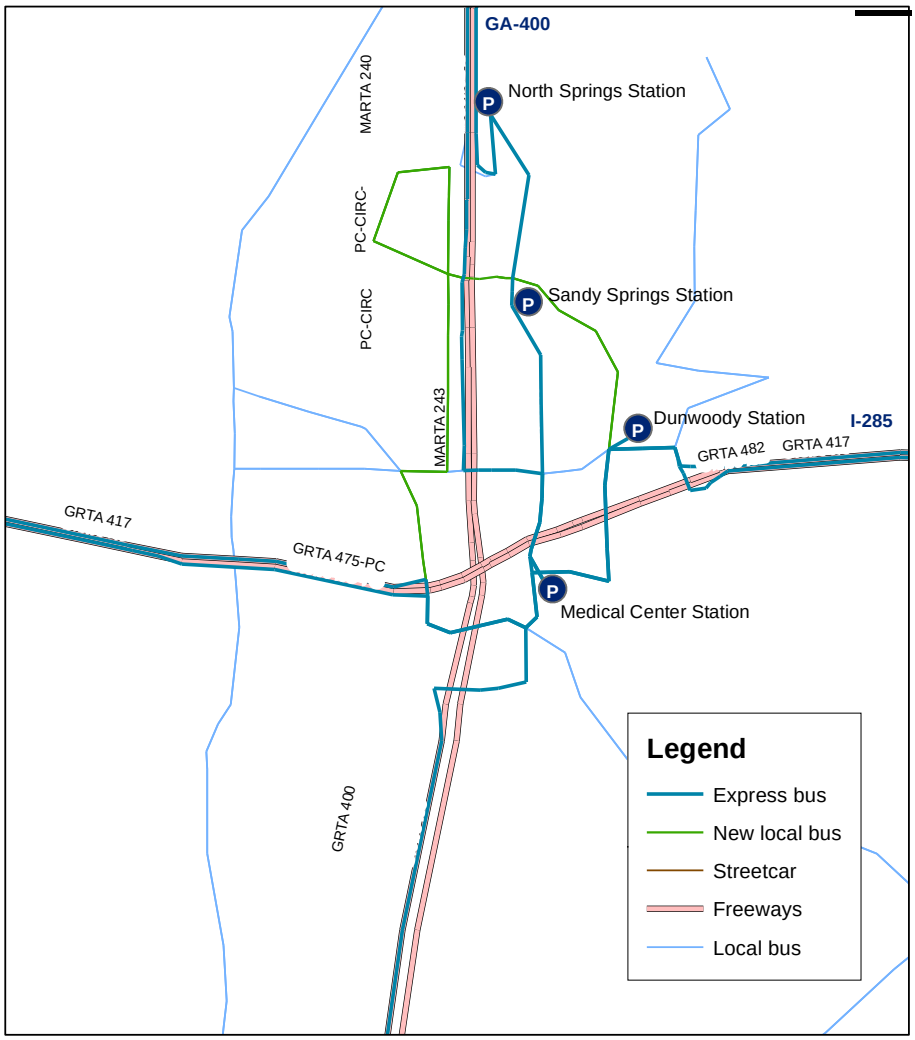

Figure 28: Perimeter Center

At Perimeter Center, the GA-400 SB express bus routes – the GRTA 400, GRTA 401, and MARTA 240 – would exit to this center to stop at Medical Center Station. That is, they exit onto Hammond Dr., stop at the interchange to allow local bus transfers, proceed east to the intersection of Hammond Dr. and Peachtree-Dunwoody Rd., stop at the intersection to allow local bus transfers, then go south on Peachtree-Dunwoody Rd. and stop outside of Medical Center Station. The GRTA 400 would continue back onto GA-400 via the Glenridge Connector, while the other buses would terminate in this area. The GA-400 NB express bus – the MARTA 243 – would begin at Medical Center Statioin and proceed north on Peachtree-Dunwoody Road, making local stops, and then enter GA-400 at North Springs Station. The I-285 WB express buses – the GRTA 417, 428, and 501 – would follow their Horizon 1 routing through Perimeter Center. The 417 would extend on Johnson Ferry Road and Glenridge Connector to get back onto I-285 WB. The I-285 EB buses – the GRTA 482 – would follow the reverse path of the WB buses. Local stops would be made along the route as appropriate.

Local bus connections will be needed in this center, at least to cover what we propose to cut from GRTA's Horizon 1 plan. There are also plenty of office building corridors that do not have local bus service. The following changes are proposed:

- New circulator route – to cover the GRTA 401 Horizon 1 routing and also serve office buildings along the west side of GA-400. This two-way route, beginning at Medical Center Station, would go west on Johnson Ferry Rd., north on the Glenridge Connector, east on Hammond Dr. (briefly), and then north on Barfield Rd. It would continue onto Glenlake Pkwy and Glenridge Dr (making a loop), then go east on Abernathy Rd to Sandy Springs Station. It would then continue the GRTA 400 Horizon 1 path, going on Perimeter Center W and Perimeter Center Pkwy to Dunwoody Station, then continue south to Medical Center Station.

- Extend the MARTA 150 west of Dunwoody Station along Hammond Dr. to the Concourse Parkway loop. This allows for easy connections with express bus. At Dunwoody Station, in the eastbound direction, have this bus just run outside of the station, rather than deviate to the bus bay.

- Extend the MARTA 85 and 185 south of North Springs Station along Peachtree-Dunwoody Rd. to Medical Center Station, following the local path of the MARTA 243.

I-85 NE and GA-141 Centers

Sugarloaf Mills and Gwinnett Place

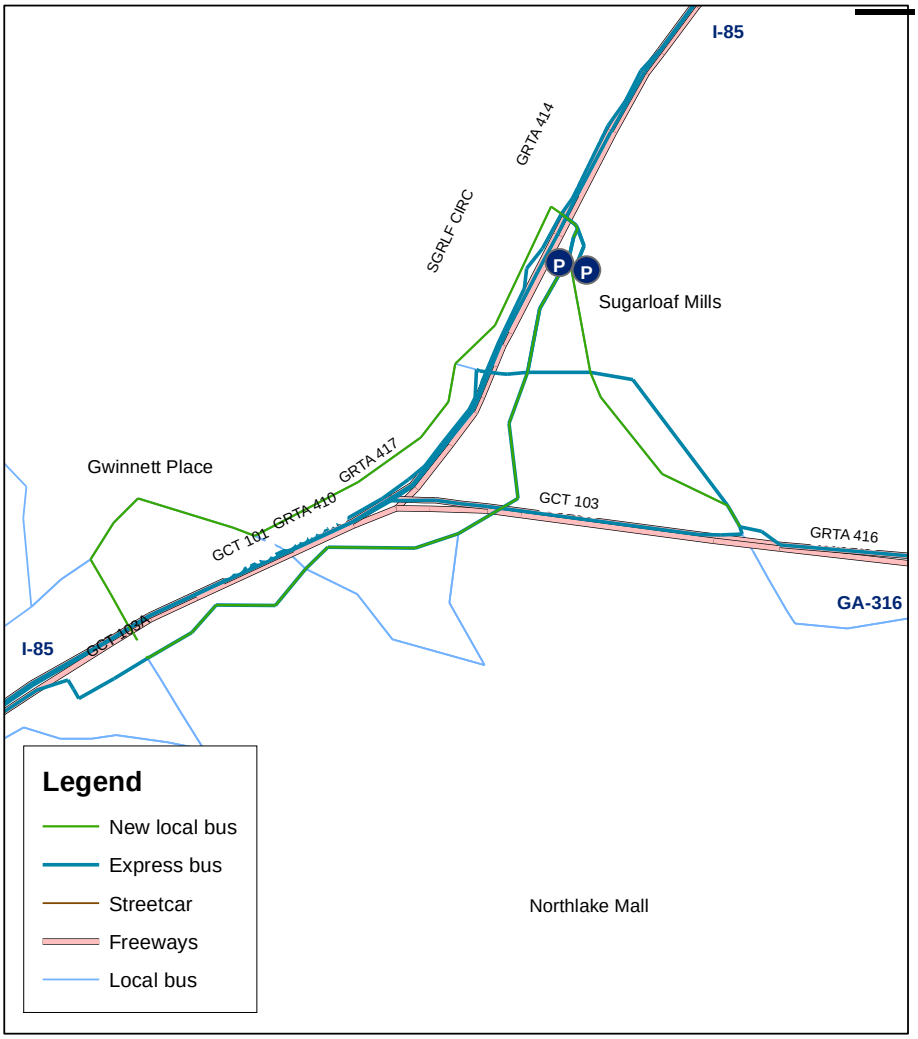

Figure 29: Sugarloaf Mills and Gwinnett Place

In the Experimental Scenario, the intermediate stop of the GRTA 414 at Sugarloaf Mills would be kept. The only passing bus in which an intermediate stop would be added is the GRTA 416, which would exit from GA-316, stop on the Sugarloaf Parkway

interchange, and then get back on the freeway. Minor construction changes at this interchange would be needed to allow the express bus simply to cross the road. Riders could transfer to the GCT 40 to access the Sugarloaf Mills hub area, allowing for additional transfers to local and other express buses. Additionally, a new one-way circulator route is proposed that also would take riders from this interchange.

This circulator would proceed from the interchange to the Sugarloaf Mills GCT P&R lot, head southwest on Breckinridge Road, northwest on Pleasant Hill Road, and then northeast on Satellite Blvd. It would end at the GCT P&R lot.

The outbound GCT 103A and GRTA 482 would follow the path of the current GCT 103A. The frequency of arrivals would dramatically increase, though, and riders would have greater connectivity in the area with the addition of the Sugarloaf Circulator.

Indian Trail and Peachtree Corners

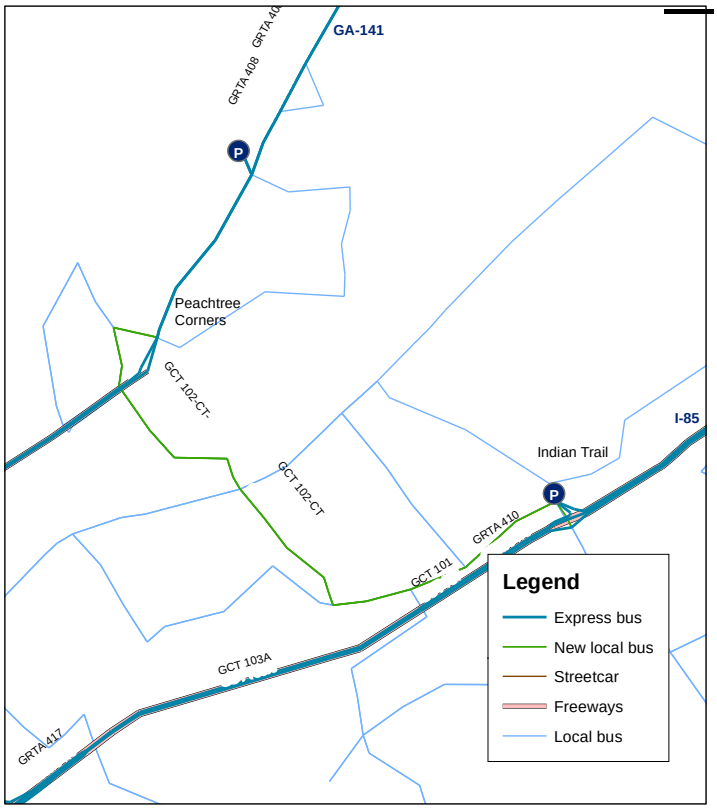

Figure 30: Indian Trail and Peachtree Corners

Several express buses on the I-85 NE corridor – the GRTA 410, GRTA 414, GRTA 416, GRTA 417, GCT 103A, and GRTA 482 – would stop at the Indian Trail P&R lot, where there is much industrial employment nearby (Google, 2015i). It also is close to the Peachtree Corners employment center. To increase the productivity of this intermediate stop, repurposing the GCT 102 is proposed, such that it travels two-way between Indian Trail and Peachtree Corners using local roads. It would begin at the Indian Trail interchange and P&R lot, use Brook Hollow Pkwy to reach Jimmy Carter Blvd (GA-140), take Jimmy Carter northwest to Holcomb Bridge Rd, then end where Holcomb Bridge meets Peachtree Pkwy. At this point, it would connect to the GRTA 408.

Doraville

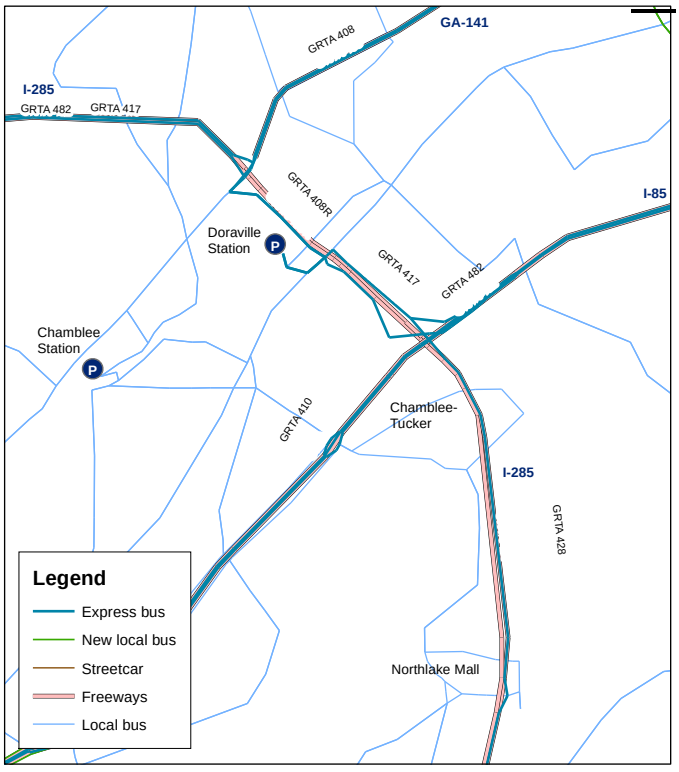

Figure 31: Doraville, Chamblee-Tucker, and Northlake

Doraville Station is the northeastern terminus of the MARTA Gold Line. The Experimental Scenario also plans this to be an express bus hub. Five GRTA Xpress buses would stop on Motors Industrial Way right outside of the station – the 408, 417, 428, 482, and 500. The 408 also would begin and end at the Doraville Station bus bay.

Several local buses, both of GCT and MARTA, currently run out of Doraville Station. It also is where a mixed use development is planned to replace the closed automobile plant (Trubey, 2015). For the streamlined Motors Industrial Way stop to be most successful, construction changes would be needed to allow easy access to the station and other local buses.

Other Centers

Northlake Mall and Chamblee-Tucker

Close to Druid Hills, these small employment centers are near one another and provide opportunities for easy express bus connections. Office buildings exist near Northlake Mall by I-285 and off of Chamblee-Tucker Road by I-85. Furthermore, Mercer University's Atlanta campus is present in this area.

In the Experimental Scenario, both the GRTA 428 and GRTA 500 would stop at Lavista Road on its I-285 interchange. Riders can transfer to and from the MARTA 30, 125, or 126. To enhance connectivity with the interchange, the 126 would be slightly extended to run on Northlake Parkway rather than Parklake Drive.

On I-85, the GRTA 410 and GCT 103A would stop on the Chamblee-Tucker Road interchange. Riders can transfer to the MARTA 33 or 126 buses, both of which feed into Chamblee Station on the Gold Line.

Druid Hills

The Druid Hills employment center is unique in that its center, the Clifton Corridor, is not located near freeways. This corridor is where Emory University and the

Center for Disease Control and Prevention (CDC) are located. However, the corridor can be served using frequent local buses coming from the freeways. Express bus can be used to connect passengers to these local buses. The I-85 and I-285 freeways are targeted for access points.

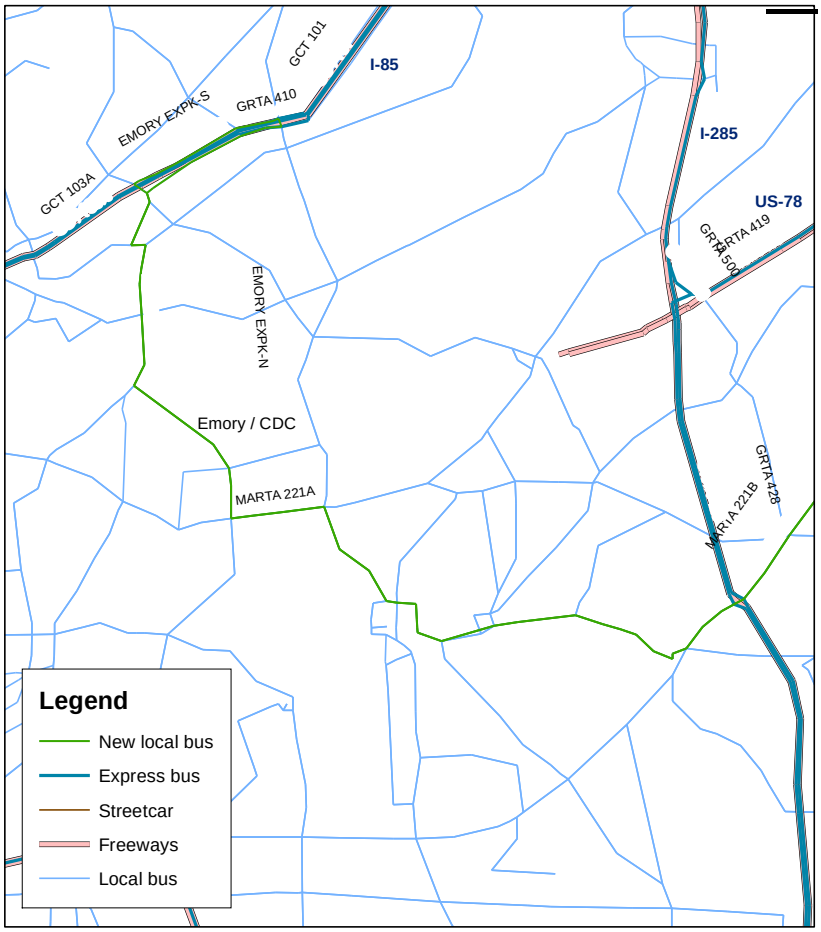

Figure 32: Druid Hills

On I-85, the several express buses would stop at the Clairmont Road interchange – GRTA 410, GRTA 414, GRTA 416, GCT 103A. Riders can transfer to the MARTA 19 or 47, which links employment along the I-85 corridor. The MARTA 19 also takes riders to the Atlanta VA Medical Center and Emory Clairmont campus (MARTA, n.d.-a). Additionally, Emory's Executive Park shuttle would be slightly extended along the I-85

Frontage Road to Clarimont Road, providing connections to Emory University and the CDC. Frequency on this shuttle would increase dramatically to every 10 minutes.

On I-285, the GRTA 428 (Panola Rd. to Perimeter Center) and GRTA 419 (Snellville to Downtown) would stop on the Memorial Drive interchange, where there are connections to the MARTA 221 and 121. The 221 is a peak-hour limited-stop version of the 121. MARTA plans to cut this route in Phase II. However, it may have potential if it extends to the Clifton Corridor. At the Memorial Drive interchange with I-285, riders would transfer from the GRTA buses to the 221. The 221 would follow its current route to Kensington Station, providing connections to the Blue Line, then proceed west on Covington Highway, N. Avondale Rd, and E. College Ave, stopping outside the Avondale MARTA station. It would proceed into Downtown Decatur, stop at the Decatur MARTA station, and then proceed on Clairemont Ave., N. Decatur Rd, and Clifton Rd. to Emory's campus. It would end near the hub point for Emory shuttles.[28]

Lindbergh Center

In this center, which is just below Buckhead, two express buses would access it: the GRTA 410 and the GCT 103A. The 410, coming from Sugarloaf Mills, would access it from I-85, using the Lindbergh Drive HOV exit. It would stop at Adina Drive, near a major shopping center and multifamily housing (Google, 2015j), and then proceed to Lindbergh Station. After stopping there, it then would continue to the I-75 NW corridor, using Piedmont Road, Piedmont Circle, Monroe Drive, and Armour Drive. Local stops would be made along the way. The bus would exit from Armour Drive onto GA-13 South.

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[28] After the model was run, the author discovered that had the 221 been extended slightly further, it would have served the CDC directly, as opposed to having riders walk further. It does not appear that this oversight had a significant effect on the results, though the author recommends having this route extend to the CDC if the plan is implemented.

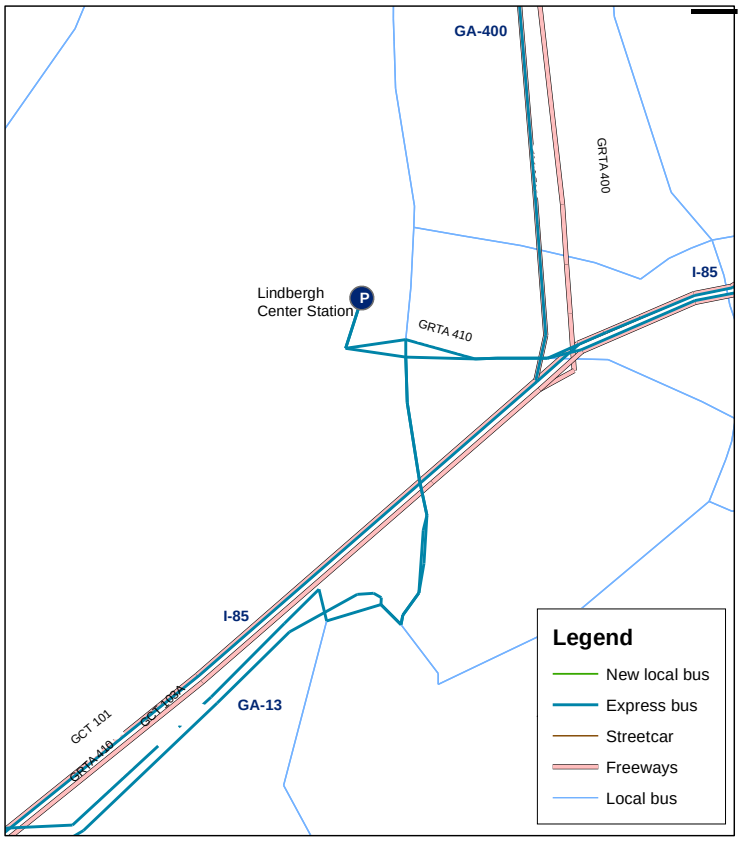

Figure 33: Lindbergh Center

The 103A, coming from Downtown, would access the area by exiting from GA-13 for Monroe Drive. It then would take Piedmont Circle and Piedmont Road to Lindbergh Center Station, making local stops along the way. It then would proceed east on Lindbergh Drive and access I-85 via the HOV exit, making the same local stops as the GRTA 410.

Airport

In the Airport area, the I-85 express buses would run by the Domestic Terminal, and the I-75 / US-41 buses would run by the International Terminal. In the Experimental Scenario, many buses running alongside the Airport would stop here.

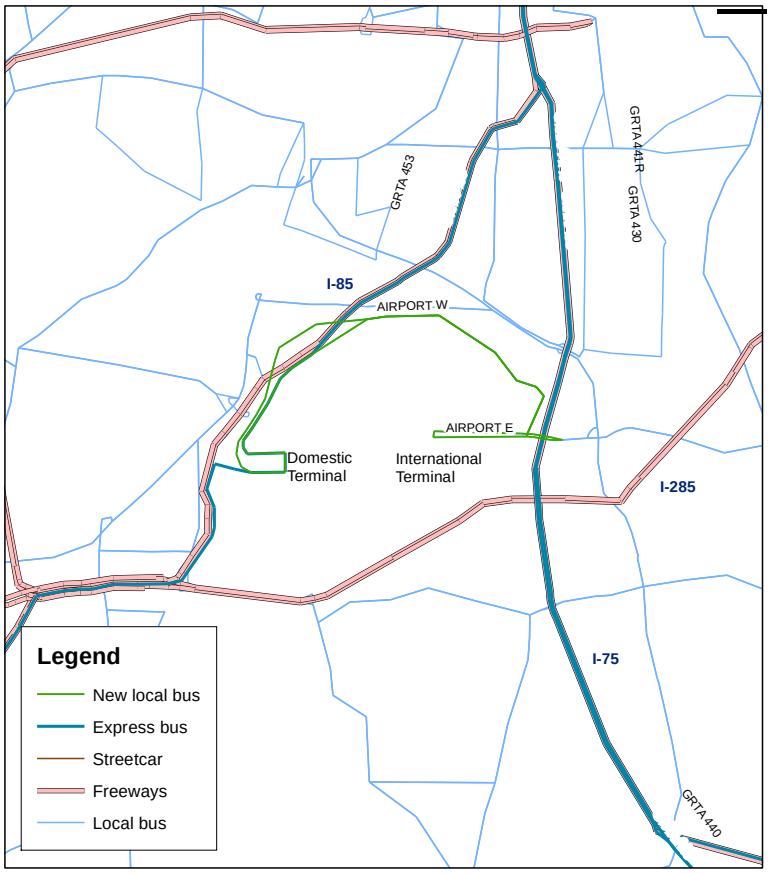

Figure 34: Hartsfield-Jackson Atlanta International Airport

From I-85 SW, the GRTA 453 would stop at the Domestic Terminal directly, as the roadway geometry facilitates fluid movement. The Red and Gold Lines run to this terminal, so riders can choose to transfer to them. Most buses from I-75 SE and US-41 South (GRTA 430, 431, 440) would stop on the HOV interchange outside of the International Terminal (at Charles W. Grant Pkwy). The reverse commute GRTA 441R would stop on this interchange as well. Riders would transfer to local and shuttle buses to reach their final destinations.

Several local bus routes are planned for the area by 2020, especially with MARTA's recent efforts to expand into Clayton County. The HOV interchange at Grant Pkwy is close to a planned local bus hub, known as the Mountain View Hub. One route,

the 191, would connect the HOV interchange and International Terminal directly. No MARTA bus is currently planned to service the Domestic Terminal directly, though, and service on the 191 would be less frequent than express bus arrivals. Thus, in the Experimental Scenario, a new airport shuttle route is proposed: running from the local bus hub to the International Terminal and then to the Domestic Terminal[29], at 15-minute headways. The shuttle would use Airport Loop Road, so Delta Airlines' headquarters and other nearby employment can be served as well.

Fulton Industrial

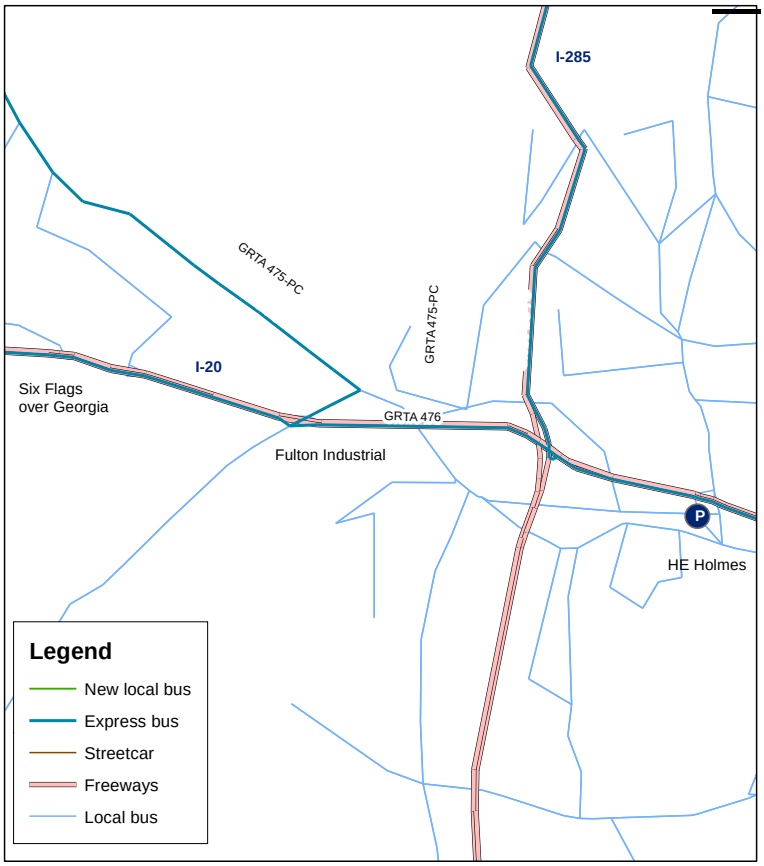

Figure 35: Fulton Industrial

[29] A shuttle between the Domestic and International Terminals that is provided by the Airport already exists (City of Atlanta, 2015), though it was not in the model. It also is unknown if the shuttle stops at other locations, such as Delta's headquarters.

The MARTA 73 local bus route provides service up and down the Fulton Industrial Blvd. corridor. In the Experimental Scenario, express buses would connect to this route at the interchange with I-20. All I-20 West and US-278 West Xpress buses would stop on the interchange – the GRTA 463, GRTA 475, and the GRTA 476. The CCT 25[30] and 30 would also stop here. Travelers would have freeway bus access to this corridor from Douglas County, Cobb County, and the MARTA Blue Line. From this hub location, riders can access a variety of destinations, including Six Flags over Georgia, the MARTA Blue Line, Downtown and Midtown, Perimeter Center, and the Airport.

Southlake Mall

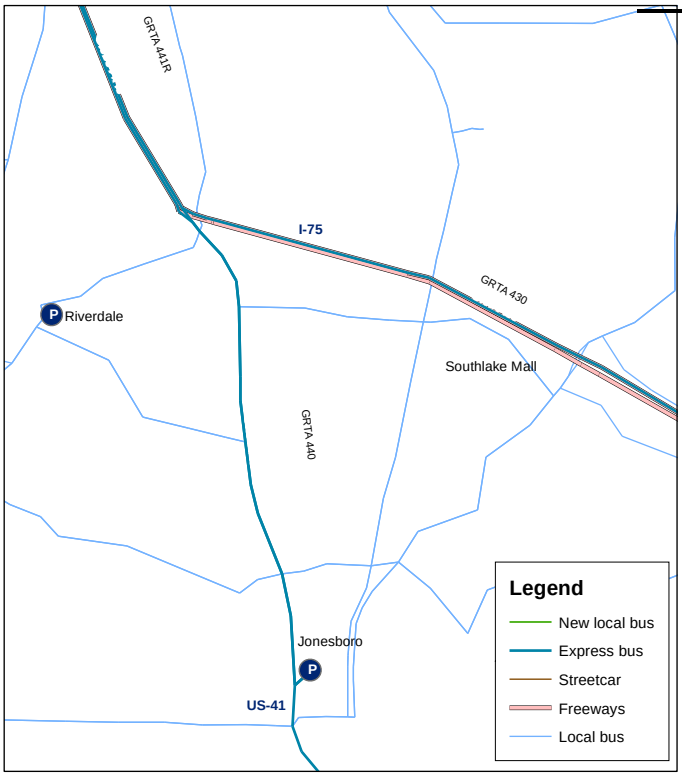

Figure 36: Southlake Mall

[30] To reiterate, even though the CCT 25 does not appear on the CCT system map, it was present in the model provided to the author. The rationale for keeping this route in the model is explained in a prior footnote.

In this area, MARTA plans to run several local bus routes and its line-haul route by 2025. The MARTA 196 currently runs to Southlake Mall from the Riverdale P&R lot. In the Experimental Scenario, the 196's peak-hour frequency would increase, and stops would be added on the GRTA 440 and 441 routes at Upper Riverdale and Mount Zion Roads to provide connectivity to this local bus. As a tradeoff, the GRTA 442 bus from Riverdale to Downtown would be discontinued. Instead, riders from the Riverdale P&R lot would take the 196 and then access Downtown or Midtown using the 440 or 441. At this intersection, the bus would stop and allow Atlanta-bound passengers to transfer to the GRTA 440 or 441.

Atlantic Station and Bellemeade

These centers lie along Northside Drive in the city of Atlanta, close to the I-75 corridor. Atlantic Station is a mixed use development directly west of northern Midtown (Atlantic Station, 2015) (Google, 2015c). For Bellemeade, aerial imagery revealed office buildings in the area (Google, 2015m), and OnTheMap shows its census tract to have relatively high population and employment. They are not major focus areas of this thesis. However, the reverse commute CCT 10C bus can easily be routed through these areas on its way to larger I-75 NW employment centers. It would follow the path of the GRTA 483 PM routing (not modeled), going through Atlantic Station on 17th Street, passing the Bellemeade area on Northside Drive, and entering I-75 via designated HOV exits. This routing would (1) provide a last-mile connection for centrally-bound employees who work in this area, and (2) serve reverse commuters living in this part of Atlanta who work on the I-75 NW corridor.

APPENDIX F

REGIONAL MEASURES FOR THE EXPERIMENTAL SCENARIO

Table 45: Results Stage 1 to Experimental with application of the air passenger model

	2020 Stage 1	2020 Experimental	Absolute Change	Percent Change
Transit share	2.17%	2.21%	0.04%	1.84%
Transit trips	411,488	419,729	8,241	2.00%
SOV person trips	11,499,395	11,492,936	-6,459	-0.06%
HOV person trips	7,094,931	7,092,570	-2,361	-0.03%
Total trips	19,005,815	19,005,235	-580	0.00%
Regional Congestion Index	1.26	1.26	0.00	0.00%

Table 46: Results Stage 1 to Experimental without application of the air passenger model

	2020 Stage 1	2020 Experimental	Absolute Change	Percent Change
Transit share	2.02%	2.07%	0.05%	2.48%
Transit trips	380,596	388,705	8,109	2.13%
SOV person trips	11,331,058	11,324,741	-6,317	-0.06%
HOV person trips	7,094,931	7,092,570	-2,361	-0.03%
Total trips	18,806,586	18,806,017	-569	0.00%

Table 47: Results Stage 1 to Experimental - HBW trips

	2020 Stage 1	2020 Experimental	Absolute Change	Percent Change
Transit share	5.23%	5.43%	0.20%	3.68%
Transit trips	222,310	230,808	8,498	3.82%
SOV person trips	3,477,756	3,472,278	-5,478	-0.16%
HOV person trips	553,442	550,383	-3,059	-0.55%
Total trips	4,253,507	4,253,468	-39	0.00%

Table 48: Results Stage 1 to Experimental NHB trips

	2020 Stage 1	2020 Experimental	Absolute Change	Percent Change
Transit share	0.74%	0.74%	0.00%	0.00%
Transit trips	42,529	42,384	-145	-0.34%
SOV person trips	3,511,840	3,511,468	-372	-0.01%
HOV person trips	2,190,872	2,191,179	307	0.01%
Total trips	5,745,241	5,745,031	-210	0.00%

Table 49: Transit trips, 2020 Stage 1 to Experimental

	2020 Stage 1	2020 Experimental	Absolute change	Percent change
Local bus	135,692	139,336	3,644	2.69%
Express bus	25,110	37,176	12,066	48.05%
Streetcar	0	0	0	
Heavy rail	219,794	212,193	-7,601	-3.46%
Total	380,596	388,705	8,109	2.13%

Table 50: Transit boardings, 2020 Stage 1 to Experimental

	2020 Stage 1	2020 Experimental	Absolute change	Percent change
Local bus	296,245	300,959	4,714	1.59%
Express bus	30,542	42,843	12,301	40.28%
Streetcar	171	178	7	4.09%
Heavy rail	297,772	290,430	-7,342	-2.47%
Total	624,730	634,410	9,680	1.55%

APPENDIX G

ROUTE BOARDINGS FOR THE EXPERIMENTAL SCENARIO

Table 51: Express Bus Boardings– 2020 Stage 1 vs Experimental

Route	Stage 1 Boardings	Experimental Boardings	Absolute Change	Percent Change
MARTA				
240	1335	1395	60	4.49%
243	108	1114	1006	931.48%
CCT				
10C	197	1163	966	490.36%
100	2850	1900	-950	-33.33%
102	450	3090	2640	586.67%
GCT				
101	416	321	-95	-22.84%
103	1279	1301	22	1.72%
103A	30	1097	1067	3556.67%
GRTA				
400	28	511	483	1725.00%
401	92	85	-7	-7.61%
408	131	268	137	104.58%
408R	65	205	140	215.38%
410	0	1191	1191	
411	165	149	-16	-9.70%
412	195	10	-185	-94.87%
413	145	118	-27	-18.62%
414	60	303	243	405.00%
416	298	1584	1286	431.54%
417	16	779	763	4768.75%
419	749	997	248	33.11%
423	1062	895	-167	-15.73%
426	4421	4444	23	0.52%
428	31	576	545	1758.06%
430	991	1094	103	10.39%
431	384	562	178	46.35%
432	1771	1593	-178	-10.05%
440	1666	2828	1162	69.75%
441	1147	1710	563	49.08%
441R	43	155	112	260.47%
442	89			*Discontinued*
453	920	1212	292	31.74%

Table 51 continued

463	2265	2575	310	13.69%
475 – PC[31]		230		
476	1763	2004	241	13.67%
480	38	57	19	50.00%
482	110	1234	1124	1021.82%
483	724	473	-251	-34.67%
490	72	1212	1140	1583.33%
500 (New)		316		

Table 52: Express Bus converted to Local Bus

Route	Stage 1 Boardings	Experimental Boardings	Absolute Change	Percent Change
MARTA				
140 PA[32]	1022	933	-89	-8.71%
140 PB	961	331	-630	-65.56%
242	178	1050	872	489.89%
CCT				
101	139	1879	1740	1251.80%
GCT				
102	135	399	264	195.56%

[31] GRTA 475 was revived in the Experimental Scenario, but rerouted to serve Perimeter Center, as explained. Ridership was forecasted to be 0 on this route in the 2020 Base Scenario, so clearly, the rerouting plan shows ridership increases.

[32] The peak-hour version of the MARTA 140, in the A direction. The off-peak version, kept as express, is beyond the scope of the analysis, though raw results can be found in Appendix L.

Table 53: Revamped Local Bus Routes

Route	Stage 1 Boardings	Experimental Boardings	Absolute Change	Percent Change
MARTA				
196A[33]	1426	1801	375	26%
196B	673	1260	587	87%
221A	811	2859	2048	253%
221B	227	685	458	202%
CCT				
10A	440	1631	1191	271%
10B	263	913	650	247%
EMORY				
EXPARK-N	17	625	608	3576%
EXPARK-S	58	1135	1077	1857%

Table 54: New Local Bus Routes

Route	Explanation	Coded Agency	Boardings
PC-CIRC	Perimeter Center Circulator	MARTA	471
PC-CIRC-			552
CCT CMB-2	Cumberland Circulator 2	CCT	319
CCT CMB-2-			283
SGRLF CIRC	Sugarloaf Mills Circulator	GCT	1329
AIRPORT W	Airport Shuttle	Shuttle	300
AIRPORT E			770

Table 55: Other Local Bus Boardings

Agency	Route	2020 Stage 1	2020 Experimental	Absolute Change	Percent Change
MARTA	1A	1423	1448	25	2%
MARTA	1B	835	828	-7	-1%
MARTA	2	560	518	-42	-8%
MARTA	-2	506	478	-28	-6%
MARTA	2S	891	858	-33	-4%
MARTA	2S-	851	852	1	0%

[33] Although the routing did not change on the 196, the frequency was doubled in anticipation of attracting riders from the discontinued GRTA 442.

Table 55 continued

MARTA	3A	13	16	3	23%
MARTA	3B	23	27	4	17%
MARTA	4A	248	245	-3	-1%
MARTA	4B	275	277	2	1%
MARTA	5	1961	2111	150	8%
MARTA	-5	2213	2234	21	1%
MARTA	6	1119	1016	-103	-9%
MARTA	-6	1724	1478	-246	-14%
MARTA	6S	796	756	-40	-5%
MARTA	6S-	1451	1239	-212	-15%
MARTA	8	158	139	-19	-12%
MARTA	-8	146	136	-10	-7%
MARTA	9	196	201	5	3%
MARTA	-9	440	454	14	3%
MARTA	12	713	699	-14	-2%
MARTA	-12	562	569	7	1%
MARTA	12S	952	923	-29	-3%
MARTA	12S-	930	928	-2	0%
MARTA	13	47	47	0	0%
MARTA	-13	108	108	0	0%
MARTA	15A	932	922	-10	-1%
MARTA	15B	341	341	0	0%
MARTA	15C A	542	531	-11	-2%
MARTA	15C B	274	270	-4	-1%
MARTA	16A	743	717	-26	-3%
MARTA	16B	530	497	-33	-6%
MARTA	19	784	648	-136	-17%
MARTA	-19	694	594	-100	-14%
MARTA	21A	990	1036	46	5%
MARTA	21B	1065	1096	31	3%
MARTA	24	34	34	0	0%
MARTA	-24	29	28	-1	-3%
MARTA	25A	109	74	-35	-32%
MARTA	25A-	77	65	-12	-16%
MARTA	25B	159	112	-47	-30%
MARTA	25B-	170	95	-75	-44%
MARTA	26	158	154	-4	-3%
MARTA	-26	177	176	-1	-1%
MARTA	27A	653	638	-15	-2%
MARTA	27B	524	520	-4	-1%
MARTA	30A	286	268	-18	-6%
MARTA	30B	533	461	-72	-14%

Table 55 continued

MARTA	32A	528	528	0	0%
MARTA	32B	1128	1142	14	1%
MARTA	33A	99	137	38	38%
MARTA	33B	68	103	35	51%
MARTA	34	139	137	-2	-1%
MARTA	-34	387	388	1	0%
MARTA	36	100	105	5	5%
MARTA	-36	153	150	-3	-2%
MARTA	37A	38	38	0	0%
MARTA	37B	132	133	1	1%
MARTA	39A	1720	1576	-144	-8%
MARTA	39B	2098	1918	-180	-9%
MARTA	42A	251	256	5	2%
MARTA	42B	340	345	5	1%
MARTA	47N	455	345	-110	-24%
MARTA	47S	322	338	16	5%
MARTA	49A	626	624	-2	0%
MARTA	49B	984	991	7	1%
MARTA	50	37	39	2	5%
MARTA	-50	38	37	-1	-3%
MARTA	51A	138	137	-1	-1%
MARTA	51B	279	257	-22	-8%
MARTA	53	10	10	0	0%
MARTA	-53	11	11	0	0%
MARTA	55A	1176	1174	-2	0%
MARTA	55B	2365	2260	-105	-4%
MARTA	56	132	132	0	0%
MARTA	-56	100	103	3	3%
MARTA	58	217	216	-1	0%
MARTA	-58	161	162	1	1%
MARTA	60	233	235	2	1%
MARTA	-60	717	719	2	0%
MARTA	64	4	4	0	0%
MARTA	-64	57	58	1	2%
MARTA	66	70	71	1	1%
MARTA	-66	109	109	0	0%
MARTA	67A	29	29	0	0%
MARTA	67B	44	44	0	0%
MARTA	68	66	65	-1	-2%
MARTA	-68	140	144	4	3%
MARTA	71	765	763	-2	0%
MARTA	-71	2029	2037	8	0%

Table 55 continued

MARTA	73A	1300	1249	-51	-4%
MARTA	73B	569	522	-47	-8%
MARTA	74A	198	196	-2	-1%
MARTA	74B	509	509	0	0%
MARTA	75	1145	972	-173	-15%
MARTA	-75	895	830	-65	-7%
MARTA	78A	371	375	4	1%
MARTA	78B	896	904	8	1%
MARTA	81	20	20	0	0%
MARTA	-81	12	12	0	0%
MARTA	83	540	538	-2	0%
MARTA	-83	1619	1622	3	0%
MARTA	84	319	320	1	0%
MARTA	-84	428	425	-3	-1%
MARTA	85A	728	702	-26	-4%
MARTA	85B	434	426	-8	-2%
MARTA	86	486	478	-8	-2%
MARTA	-86	1044	1035	-9	-1%
MARTA	87	714	747	33	5%
MARTA	-87	1019	988	-31	-3%
MARTA	89	147	149	2	1%
MARTA	-89	285	288	3	1%
MARTA	93A	54	53	-1	-2%
MARTA	93B	31	30	-1	-3%
MARTA	95	2299	2259	-40	-2%
MARTA	-95	1939	1482	-457	-24%
MARTA	99A	23	26	3	13%
MARTA	99A-	32	39	7	22%
MARTA	99B	15	15	0	0%
MARTA	99B-	14	15	1	7%
MARTA	103A	273	264	-9	-3%
MARTA	103B	297	279	-18	-6%
MARTA	104A	48	47	-1	-2%
MARTA	104B	194	195	1	1%
MARTA	107	1564	1618	54	3%
MARTA	-107	2098	2109	11	1%
MARTA	110	924	941	17	2%
MARTA	-110	1013	996	-17	-2%
MARTA	110A	878	875	-3	0%
MARTA	110A-	847	834	-13	-2%
MARTA	111	22	21	-1	-5%
MARTA	-111	16	16	0	0%

Table 55 continued

MARTA	114	303	279	-24	-8%
MARTA	-114	342	387	45	13%
MARTA	115	264	261	-3	-1%
MARTA	-115	960	960	0	0%
MARTA	115S	120	119	-1	-1%
MARTA	115S-	630	617	-13	-2%
MARTA	116	255	258	3	1%
MARTA	-116	859	894	35	4%
MARTA	116S	85	87	2	2%
MARTA	116S-	623	672	49	8%
MARTA	117	815	751	-64	-8%
MARTA	-117	1537	1368	-169	-11%
MARTA	119	69	66	-3	-4%
MARTA	-119	124	123	-1	-1%
MARTA	120	1507	1493	-14	-1%
MARTA	-120	2117	2125	8	0%
MARTA	121	1148	1111	-37	-3%
MARTA	-121	1872	1840	-32	-2%
MARTA	123	38	8	-30	-79%
MARTA	-123	83	26	-57	-69%
MARTA	124	734	732	-2	0%
MARTA	-124	1190	1175	-15	-1%
MARTA	125A	803	697	-106	-13%
MARTA	125B	553	526	-27	-5%
MARTA	126A	351	202	-149	-42%
MARTA	126B	433	183	-250	-58%
MARTA	132	583	572	-11	-2%
MARTA	-132	542	528	-14	-3%
MARTA	150	164	108	-56	-34%
MARTA	-150	356	202	-154	-43%
MARTA	153A	318	320	2	1%
MARTA	153B	59	60	1	2%
MARTA	162	282	281	-1	0%
MARTA	-162	768	774	6	1%
MARTA	165	283	287	4	1%
MARTA	-165	620	621	1	0%
MARTA	170	15	15	0	0%
MARTA	-170	15	16	1	7%
MARTA	178A	506	500	-6	-1%
MARTA	178B	250	250	0	0%
MARTA	180A	492	501	9	2%
MARTA	180B	823	831	8	1%

Table 55 continued

MARTA	181A	545	531	-14	-3%
MARTA	181B	525	537	12	2%
MARTA	183A	78	79	1	1%
MARTA	183B	45	44	-1	-2%
MARTA	185A	389	333	-56	-14%
MARTA	185B	586	508	-78	-13%
MARTA	186A	839	829	-10	-1%
MARTA	186B	239	240	1	0%
MARTA	189	565	583	18	3%
MARTA	-189	1010	982	-28	-3%
MARTA	191A	601	634	33	5%
MARTA	191B	185	185	0	0%
MARTA	192	1407	1029	-378	-27%
MARTA	-192	989	718	-271	-27%
MARTA	193	291	284	-7	-2%
MARTA	-193	207	200	-7	-3%
MARTA	193S	64	64	0	0%
MARTA	193S-	59	58	-1	-2%
MARTA	194A	397	408	11	3%
MARTA	194B	179	171	-8	-4%
MARTA	195A	222	122	-100	-45%
MARTA	195B	219	155	-64	-29%
MARTA	196A	1426	1801	375	26%
MARTA	196B	673	1260	587	87%
MARTA	197A	139	189	50	36%
MARTA	197B	139	128	-11	-8%
MARTA	198	111	105	-6	-5%
MARTA	-198	69	65	-4	-6%
MARTA	221A	811	2859	2048	253%
MARTA	221B	227	685	458	202%
CCT	10N	3172	2632	-540	-17%
CCT	10S	2952	1957	-995	-34%
CCT	10A	440	1631	1191	271%
CCT	10B	263	913	650	247%
CCT	15	711	705	-6	-1%
CCT	-15	439	410	-29	-7%
CCT	20N	725	559	-166	-23%
CCT	20S	1058	1113	55	5%
CCT	25N	418	602	184	44%
CCT	25S	491	577	86	18%
CCT	30	1518	1612	94	6%
CCT	30	1172	1454	282	24%

Table 55 continued

CCT	40	312	251	-61	-20%
CCT	40	232	200	-32	-14%
CCT	45	161	145	-16	-10%
CCT	-45	116	123	7	6%
CCT	50	1062	441	-621	-58%
CCT	50	699	387	-312	-45%
CCT	CMBRLND	418	35	-383	-92%
GCT	10A	1335	956	-379	-28%
GCT	10B	2131	1499	-632	-30%
GCT	20	1292	1052	-240	-19%
GCT	20	1035	1075	40	4%
GCT	30	898	719	-179	-20%
GCT	30	812	710	-102	-13%
GCT	35A	988	839	-149	-15%
GCT	35B	1130	873	-257	-23%
GCT	40A	1733	1441	-292	-17%
GCT	40B	1308	1137	-171	-13%
HAT 1	N	75	75	0	0%
HAT 1	S	56	56	0	0%
HAT 1	S-	101	101	0	0%
HAT 3	A	214	213	-1	0%
HAT 3	B	173	173	0	0%
HAT 4	0	172	171	-1	-1%
HAT 4	-	159	159	0	0%
HAT 5	0	151	151	0	0%
HAT 5	-	178	178	0	0%
HAT 6	0	107	107	0	0%
HAT 6	-	37	37	0	0%
ATLANTIC STN		28		25	-3
ATLANTIC STN-		105		107	2
AUC A	0	340	340	0	0%
AUC B	0	158	159	1	1%
BUC	BLUE	182	178	-4	-2%
BUC	BLUE-	381	384	3	1%
BUC	RED	13	1	-12	-92%
BUC	RED-	68	1	-67	-99%
EMORY	A	27	17	-10	-37%
EMORY	A-	88	27	-61	-69%
EMORY	B	149	56	-93	-62%
EMORY	C	269	235	-34	-13%
EMORY	C-	32	23	-9	-28%
EMORY	CCTMA	1251	370	-881	-70%

Table 55 continued

EMORY	CCTMA-	99	40	-59	-60%
EMORY	D	207	212	5	2%
EMORY	E	114	100	-14	-12%
EMORY	E-	14	9	-5	-36%
EMORY	EUHM A	0	0	0	
EMORY	EUHM B	0	0	0	
EMORY	EXPARK	17	625	608	3576%
EMORY	EXPARK-	58	1135	1077	1857%
EMORY	GRADY	0	0	0	
EMORY	GRADY-	0	0	0	
EMORY	LOOP	104	99	-5	-5%
EMORY	M	2	4	2	100%
EMORY	M-	1	3	2	200%
EMORY	NDEK	1400	1089	-311	-22%
EMORY	NDEK-	150	120	-30	-20%
EMORY	SDEK	519	233	-286	-55%
EMORY	SDEK-	56	31	-25	-45%
EMORY	VA	45	39	-6	-13%
EMORY	VA-	5	3	-2	-40%
KSU	BLACK	300	306	6	2%
KSU	BLUE	227	246	19	8%
KSU	GOLD	4	2	-2	-50%
KSU	GOLD-	20	5	-15	-75%
KSU	GREEN	103	97	-6	-6%
TECH	TROLLEY	148	251	103	70%
TECH	TROLLEY-	42	74	32	76%
TECH	BLUE	138	157	19	14%
TECH	GREEN	136	138	2	1%
TECH	RED	104	112	8	8%
TECH	EMORY	35	13	-22	-63%
TECH	EMORY-	15	12	-3	-20%
STATE	BLUE	1522	1536	14	1%
STATE	GREEN	86	93	7	8%
STATE	RED	4	6	2	50%
WESTGA	APT	37	37	0	0%
WESTGA	APT-	30	30	0	0%
WESTGA	BLUE	13	13	0	0%
WESTGA	RED	29	29	0	0%
WESTGA	GREY	42	42	0	0%
WESTGA	GREY-	38	38	0	0%

APPENDIX H

NODE-LEVEL RESULTS FOR THE EXPERIMENTAL SCENARIO

This appendix shows the number of boardings and alightings at select nodes in non-central employment locations, where express bus would be making intermediate stops. Some employment centers, such Perimeter Center, have many express bus stops, and not all are listed in this appendix. This appendix simply focuses on modeled volumes for hub stops and transfer points to local transit. For each table, routes that terminate at the respective node are not listed, as it is assumed that all remaining passengers from the previous stop would alight. The primary goal of this appendix is to illustrate the effectiveness of intermediate stops.

I-75 NW

Town Center

Table 56: I-75 & Big Shanty Rd (Node 59332)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	CCT 102	1320.31	16.64	67.02	1269.93
Express	CCT 10C	233.91	10.17	7.26	236.82
Express	GRTA 410	43.23	0	0	43.23
Express	GRTA 417	25.18	0	0	25.18
Express	GRTA 480	58.04	0.01	30.72	27.33
Express	GRTA 483	350.23	0	57.79	292.44
Express	GRTA 490	978.54	0	55.04	923.5

Table 57: Big Shanty P&R lot (Node 47388)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	CCT 102	1269.93	971.95	59.61	2182.27
Express	GRTA 480	27.33	0	27.33	0
Express	GRTA 482	0	745.13	0	745.13
Express	GRTA 483	375.1	30.52	55.39	350.23
Express	GRTA 490	735.09	303.6	60.14	978.55

Table 58: Big Shanty Rd & George Busbee Pkwy (Node 8083)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	CCT 100	1847.36	53.86	26.31	1874.91
Express	CCT 10C	282.11	9.28	57.48	233.91
Express	GRTA 410	47.88	0	4.65	43.23
Express	GRTA 417	27.75	0	2.57	25.18
Local	CCT 40	20.7	0.03	20.7	0.03
Local	CCT 40-	9.48	8.78	3.76	14.5
Local	CCT 45	2.05	0	2.05	0
Local	CCT 45-	0	0.74	0	0.74
Local	KSU BLACK	35.15	82.56	35.15	82.56

Table 59: Chastain Road and Townpark Dr (Node 7735)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 483	355.52	46.32	26.74	375.1
Express	GRTA 490	714.7	46.37	25.98	735.09
Local	CCT 45	2.05	0	0	2.05
Local	CCT 45-	0.74	0	0	0.74

Marietta

Table 60: I-75 South & Roswell Rd (Node 47238)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	CCT 102	2182.27	256.44	204.08	2234.63
Express	GRTA 482	745.13	138.31	113.37	770.07
Express	GRTA 490	923.5	51.63	245.09	730.04
Local	CCT 101-S	212.79	30.56	185.94	57.41
Local	CCT 101-S-	108.47	303.77	106.87	305.37

Table 61: I-75 North & N. Marietta Pkwy (Node 7312)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	CCT 10C	470.71	83.93	149.32	405.32
Express	GRTA 410	137.59	0	66.03	71.56
Express	GRTA 417	80.25	0	39.24	41.01
Local	CCT 101-N	7.93	76.62	7.93	76.62
Local	CCT 101-N-	43.16	15.5	42.95	15.71

Cumberland

Cumberland North

Table 62: I-75 South & Terrell Mill Rd (Node 47223)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	CCT 102	2234.63	301.86	169.49	2367
Express	GRTA 482	770.07	136.4	209.26	697.21
Express	GRTA 490	730.04	49.6	297.38	482.26
Local	CCT 10A-E	83.64	139.33	70.1	152.87
Local	CCT 10A-W	131.73	35.91	49.35	118.29
Local	CCT CMB-2	0	36.65	0	36.65

Table 63: I-75 North & Windy Hill Rd (Node 8581)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	CCT 10C	715.34	60.06	304.69	470.71
Express	GRTA 410	264.98	0	127.39	137.59
Express	GRTA 417	157.26	0	77.01	80.25
Local	CCT 10A-E	110.07	4.46	17.53	97
Local	CCT 10A-W	14.32	98.14	3.25	109.21
Local	CCT 10B-E	1.15	2.62	1.15	2.62
Local	CCT 10B-W	0	14.12	0	14.12
Local	CCT 15	21.17	0.03	21.17	0.03
Local	CCT 15-	0	57.42	0	57.42

Cumberland South

Table 64: I-75 South & Cumberland Blvd (Node 8092)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	CCT 102	2367	224.04	470.21	2120.83
Express	GRTA 490	482.26	41.86	123.76	400.36
Local	CCT 10A-E	142.57	46.62	26.8	162.39
Local	CCT 10A-W	54.81	56.16	29.54	81.43
Local	CCT 10B-E	54.01	55.13	24.53	84.61
Local	CCT 10B-W	37.25	25.42	32.98	29.69
Local	CCT 50	2.88	2.7	0.04	5.54
Local	CCT 50-	1.01	0.12	0.68	0.45
Local	CCT CMB-2	39.2	47.43	19.63	67
Local	CCT CMB-2-	39.83	25.42	26.14	39.11

Table 65: I-75 North & Cumberland Blvd (Node 8093)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	CCT 10C	869.64	38.91	193.21	715.34
Express	GRTA 410	417.43	0	152.45	264.98
Local	CCT 10A-E	162.37	67.63	7.06	222.94
Local	CCT 10A-W	31.52	24.98	1.69	54.81
Local	CCT 10B-E	28.56	27.14	1.69	54.01
Local	CCT 10B-W	29.69	28.92	4.27	54.34
Local	CCT 50	0.03	2.84	0	2.87
Local	CCT 50-	0.45	3.48	0.31	3.62
Local	CCT CMB-2	24.67	19.58	5.05	39.2
Local	CCT CMB-2-	39.11	43.02	7.2	74.93

Cumberland West

Table 66: I-285 North & Cobb Pkwy (Node 4846)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 475-PC	137.01	52.63	100.25	89.39
Local	CCT 10A-E	2.19	7.61	0	9.8
Local	CCT 10A-W	44.94	15.18	29.26	30.86
Local	CCT 50-	0	0.88	0	0.88
Local	CCT CMB-2-	0	9.15	0	9.15

Cumberland East

Table 67: I-285 East & Northside Drive (Node 4998)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 475-PC	89.39	15.86	0.39	104.86
Express	GRTA 482	697.21	23.49	1.6	719.1
Local	CCT 10A-E	132.76	0	38.28	94.48

Table 68: I-285 East & New Northside Drive (Node 8874)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 475-PC	104.86	15.26	18.79	101.33
Express	GRTA 482	719.1	23.35	81.69	660.76
Local	CCT 10A-W	12.52	0	3.69	8.83

Table 69: I-285 West & New Northside Drive (Node 8820)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 417	263.68	2.11	106.23	159.56
Local	CCT 10A-W	8.83	9.8	0.1	18.53

Table 70: I-285 West & Northside Drive (Node 4996)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 417	159.56	0.26	2.56	157.26
Local	CCT 10A-W	132.75	0.01	0	132.76

GA-400

North Point and Windward

Windward Parkway @ GA-400

Table 71: Windward Pkwy & GA-400 South – Node 5669

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 400	464.57	2.26	105.73	361.1
Local	MARTA 140 PA	43.7	0	0.56	43.14
Local	MARTA 140 PB	32.99	34.74	0	67.73
Local	MARTA 185A	14.28	0	0.1	14.18
Local	MARTA 185B	6.93	6.18	0	13.11
Local	MARTA 242	27.47	2.73	0.51	29.69
Local	MARTA 242-	61.29	9.29	0.4	70.18

Table 72: Windward Pkwy & GA-400 North – Node 5682

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	MARTA 243	438.01	11.37	70.83	214.15
Local	MARTA 140 PA	43.14	0	5.92	37.22
Local	MARTA 140 PB	0	32.99	0	32.99
Local	MARTA 185A	14.18	0	2.92	11.26
Local	MARTA 185B	0	6.93	0	6.93
Local	MARTA 242	0.51	26.96	0	27.47
Local	MARTA 242-	70.18	64.63	4.45	130.36

Mansell Road @ GA-400

Table 73: Mansell Rd & GA-400 South (Mansell P&R lot)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 400	361.1	11.37	70.83	301.64
Express	MARTA 240	699.57	669.09	41.27	1327.39
Local	MARTA 140 PA	0	26.87	0	26.87
Local	MARTA 242	71.43	13.49	4.78	80.14
Local	MARTA 242-	46.67	9.54	44.81	11.4
Local	MARTA 85A	6.43	10.38	0	16.81
Local	MARTA 85B	9.86	4.35	4.22	9.99

Table 74: Mansell Rd & GA-400 North

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	MARTA 243	881.13	57.25	500.37	438.01
Local	MARTA 140 PA	26.87	221.24	8.7	239.41
Local	MARTA 140 PB	57.42	0	2.12	55.3
Local	MARTA 242	5.65	66.65	0.87	71.43
Local	MARTA 242-	11.4	6.69	10.56	7.53
Local	MARTA 85A	0	6.43	0	6.43

Perimeter Center

Table 75: GA-400 South & Hammond Dr (Node 9398)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 400	301.64	0	36.65	264.99
Express	GRTA 401	86.3	0	16.02	70.28
Express	MARTA 240	1327.39	16.96	240.23	1104.12
Local	MARTA 5	312.6	119.22	0	431.82
Local	MARTA 5-	114.27	0.31	2.95	111.63
Local	MARTA 87	310.44	52.83	0	363.27
Local	MARTA 87-	352.84	0.15	13.7	339.29

Table 76: Hammond Dr & Peachtree-Dunwoody Rd (Node 5060)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 400	238.39	0.34	39.28	199.45
Express	GRTA 401	58.61	0	17.17	41.44
Express	MARTA 240	971.44	8.59	137.49	842.54
Express	MARTA 243	73	76.73	0.91	148.82
Local	MARTA 150	0.14	5.21	0	5.35
Local	MARTA 150-	5.46	0	2.64	2.82
Local	MARTA 185A	5.71	0.1	0	5.81
Local	MARTA 185B	6.86	0	0	6.86
Local	MARTA 5	321.07	0	0	321.07
Local	MARTA 5-	112.02	19.64	18.22	113.44
Local	MARTA 85A	11.05	0	5.59	5.46
Local	MARTA 85B	7.53	2.62	0	10.15
Local	MARTA 87	311.64	3.03	0	314.67
Local	MARTA 87-	339.49	9.63	23.46	325.66

Table 77: Peachtree-Dunwoody Rd & Medical Center Transit Link (Node 10453)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 400	190.17	0	55.09	135.08
Express	GRTA 401	37.37	0	24.08	13.29
Express	MARTA 240	782.12	0	68.28	713.84
Express	MARTA 243	11.94	61.06	0	73
Local	MARTA 185A	0	5.71	0	5.71
Local	MARTA 185B	6.86	0	6.86	0
Local	MARTA 25B	1.92	0.09	0	2.01
Local	MARTA 25B-	4.28	0	1.94	2.34
Local	MARTA 85A	5.46	0	5.46	0
Local	MARTA 85B	0	7.53	0	7.53

Table 78: Peachtree-Dunwoody Road and Lake Hearn Dr (Node 17962)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 400	135.08	0	30.41	104.67
Express	GRTA 417	332.49	85.11	169.03	248.57
Express	GRTA 475-PC	65.36	0	45.07	20.29
Express	GRTA 482	515	18.85	275.96	257.89
Local	MARTA 25B	2.01	0.08	0	2.09
Local	MARTA 25B-	4.28	0	0	4.28
Local	PC-CIRC	4.38	56.08	0	60.46
Local	PC-CIRC-	0.24	1.17	0	1.41

Table 79: Peachtree-Dunwoody Rd centroid connector near Johnson Ferry Rd (Node 5059)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 400	104.67	0	0	104.67
Express	GRTA 417	248.57	26.44	11.33	263.68
Express	GRTA 475-PC	71.6	0	6.24	65.36
Express	GRTA 482	559.59	5.69	50.28	515
Local	MARTA 25B	2.09	0	0	2.09
Local	MARTA 25B-	6.45	0	2.17	4.28
Local	PC-CIRC	60.46	2.32	2.49	60.29
Local	PC-CIRC-	22.61	0	10.33	12.28

Table 80: I-285 East & Glenridge Connector (Node 5031)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 475-PC	101.33	0	29.73	71.6
Express	GRTA 482	660.76	8.14	109.31	559.59
Local	PC-CIRC	1.39	45.84	0	47.23
Local	PC-CIRC-	11.12	0	0	11.12

Table 81: Hammond Dr. & Perimeter Center Parkway (near Dunwoody Station) (Node 4789)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 417	357.52	86.1	118.45	325.17
Express	GRTA 428	96.72	7.99	58.79	45.92
Express	GRTA 475-PC[34]	17.52	0	0	17.52
Express	GRTA 482	262.88	39.48	109.03	193.33
Express	GRTA 500	121.99	5.99	59.5	68.48
Local	MARTA 150	5.35	38.55	0.26	43.64
Local	MARTA 150-	36.33	6.74	33.69	9.38
Local	MARTA 5	236.51	96.31	0	332.82
Local	MARTA 5-	113.44	0	17.98	95.46
Local	MARTA 87	246.36	71.16	0	317.52
Local	MARTA 87-	325.66	0	42.89	282.77
Local	PC-CIRC	14.78	1.89	12.29	4.38
Local	PC-CIRC-	54.47	40.36	47.32	47.51

Table 82: Hammond Dr & Ashfortd-Dunwoody Road (Node 4778)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 417	452.53	18.35	72	398.88
Express	GRTA 428	134.51	4.18	34.46	104.23
Express	GRTA 482	180.93	14.24	37.87	157.3
Express	GRTA 500	160.02	3.13	25.89	137.26
Local	MARTA 150	43.64	8.52	0	52.16
Local	MARTA 150-	47.79	0	11.46	36.33

[34] Note: The GRTA 475-PC is the only express bus that would stop directly in the Dunwoody Station bus bay, as the station is the route's terminus. Other express buses would just run alongside this station at this node. Thus, while the 475 shows no boardings or alightings, it is expected that at the subsequent node, all passengers will alight the bus.

I-85 NE and GA-141

Sugarloaf Mills and Gwinnett Place

Table 83: GA-316 West & Sugarloaf Pkwy (Node 7025)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GCT 103	952.96	349.21	170.48	1131.69
Express	GRTA 416	673.7	85.89	168.47	591.12
Local	GCT 40A	122.48	33.23	95.06	60.65
Local	GCT 40B	265.63	7.7	249.47	23.86
Local	SGRLF CIRC	0	25.92	0	25.92

Table 84: GRTA P&R lot (Node 23011)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 410	0	6.95	0	6.95
Express	GRTA 412	0	0.07	0	0.07
Express	GRTA 414	61.32	0.9	1.37	60.85
Express	GRTA 417	0	3.19	0	3.19

Table 85: GCT P&R lot - north end (Node 63020)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GCT 103	0	952.96	0	952.96
Express	GRTA 410	6.95	367.38	0.09	374.24
Express	GRTA 412	0.07	10.84	0.07	10.84
Express	GRTA 414	60.85	71.56	3.75	128.66
Express	GRTA 417	3.19	262.03	0	265.22
Local	GCT 10B	0	0.04	0	0.04

Table 86: GCT P&R lot - south end (Node 31622)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GCT 103A[35]	136.88	0	36.17	100.71
Local	GCT 10B	0.04	0.53	0	0.57
Local	GCT 40A	131.97	27.42	36.91	122.48
Local	GCT 40B	22.93	0.3	18.2	5.03
Local	SGRLF CIRC	24.09	1.21	4.09	21.21

Table 87: Breckinridge Blvd & Pleasanthill Rd (Node 8745)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GCT 103A	320.02	0	23.76	296.26
Express	GRTA 482	64.35	0	4.56	59.79
Local	SGRLF CIRC	8.93	19.93	3.34	25.52

Indian Trail and Peachtree Corners

Table 88: Indian Trail & I-85 South

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 410	374.24	114.07	0	488.31
Express	GRTA 414	128.65	39.1	56.25	111.5
Express	GRTA 416	591.12	159.46	71.17	679.41
Express	GRTA 417	265.23	58.69	48.41	275.51
Local	GCT 102-CT	23.73	74.64	1.82	96.55
Local	GCT 102-CT-	34.45	7.38	17.91	23.92
Local	GCT 20	24.05	22.4	18.87	27.58
Local	GCT 20-	195.86	7.51	184.65	18.72

[35] The GRTA 482 follows the path of the GCT 103A in this area and also stops here. However, unlike the GCT 103A, it ends here, so it is not included in this table (as explained at the beginning of the appendix). The GCT 103A extends one node further to the north end of the GCT P&R lot. This difference in coding was accidental and not discovered until after the model had been run. However, it is not expected to make a significant difference in the overall results.

Table 89: Indian Trail P&R lot

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 410	488.31	156.98	0	645.29
Express	GRTA 414	111.49	52.17	33.1	130.56
Express	GRTA 416	679.42	528.97	36.63	1171.76
Express	GRTA 417	275.51	143.86	29.88	389.49

Table 90: Indian Trail & I-85 North

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GCT 103A	569.7	79.83	165.06	484.47
Express	GRTA 482	159.3	0	53.92	105.38
Local	GCT 102-CT	0	23.73	0	23.73
Local	GCT 20	27.58	18	12.55	33.03
Local	GCT 20-	202.12	13.02	19.28	195.86

Table 91: GA-141 and Holcomb Bridge Rd (Node 5526)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 408	221.7	8.68	38.51	191.87
Express	GRTA 408R	98.98	75.5	9.99	164.49
Local	GCT 102-CT-	0	4.13	0	4.13
Local	GCT 35A	2.66	0	2.24	0.42
Local	GCT 35B	36.95	0.75	2.03	35.67

Doraville

Table 92: Former auto plant stop[36] (Node 5454)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 408	206.03	16.5	0.83	221.7
Express	GRTA 408R	164.49	1.69	51.04	115.14
Express	GRTA 417	411.04	53.36	11.88	452.52
Express	GRTA 428	117.95	53.37	36.81	134.51
Express	GRTA 482	157.3	19.52	36.2	140.62
Express	GRTA 500	137.32	40.03	17.33	160.02
Local	MARTA 25A	0	0.14	0	0.14
Local	MARTA 25A-	0	0	0	0

Table 93: MIW[37] stop outside Doraville Station (Node 5414)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 408	186.28	19.75	0	206.03
Express	GRTA 408R	115.14	0.02	4.36	110.8
Express	GRTA 417	389.49	24.79	3.23	411.05
Express	GRTA 428	156.04	25	63.08	117.96
Express	GRTA 482	140.62	45.4	26.72	159.3
Express	GRTA 500	152.08	18.75	33.51	137.32
Local	MARTA 25A	0	0	0	0
Local	MARTA 25A-	0	0	0	0

[36] Source: (Kahn, 2015)
[37] MIW: Motors Industrial Way

Other Centers

Northlake Mall and Chamblee-Tucker

Chamblee-Tucker & I-85

Table 94: Chamblee-Tucker Rd & I-85 South (Node 5377)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 410	645.29	191.51	142.24	694.56
Local	MARTA 126A	10.91	10.99	3.95	17.95
Local	MARTA 126B	39.08	0	3.01	36.07
Local	MARTA 33A	3.36	1.3	3.17	1.49
Local	MARTA 33B	1.59	0	0	1.59

Table 95: Chamblee Tucker Rd & I-85 North (Node 5378)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GCT 103A	668.33	71.96	170.59	569.7
Local	MARTA 126A	17.95	1.39	0	19.34
Local	MARTA 126B	44.85	0	5.77	39.08
Local	MARTA 33B	1.59	0	0	1.59

Northlake Mall

Table 96: I-285 North & Lavista Road (Node 4210)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 428	270.05	47.61	161.61	156.05
Express	GRTA 500	210.27	35.7	93.89	152.08
Local	MARTA 125A	25.79	0	25.79	0
Local	MARTA 125B	21.97	14.83	4.5	32.3
Local	MARTA 126A	7.76	0	7.76	0
Local	MARTA 126B	0	6.16	0	6.16
Local	MARTA 30B	16.93	8.47	3.09	22.31

Druid Hills

Clairmont Road & I-85

Table 97: Clairmont Rd & I-85 South (Node 4239)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 410	694.56	178.18	93.36	779.38
Express	GRTA 414	130.56	0	130.56	0
Express	GRTA 416	1171.76	101.43	291.9	981.29
Local	EMORY EXPK-S	0	383.99	0	383.99
Local	MARTA 19	54.9	9.42	1.36	62.96
Local	MARTA 19-	30.08	31.24	2.7	58.62
Local	MARTA 47S	214.66	0	34.69	179.97

Table 98: Clairmont Rd & I-85 North (Node 4110)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GCT 103A	624.61	141.17	97.45	668.33
Local	EMORY EXPK-N	239.31	0	72.31	167
Local	EMORY EXPK-S	0	0	0	0
Local	MARTA 19	64.25	1.99	11.34	54.9
Local	MARTA 19-	58.62	3.9	3.2	59.32
Local	MARTA 47N	12.21	3.25	0	15.46

Memorial Drive

Table 99: I-285 North & Memorial Drive (Node 4161)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 428	340.82	79.14	149.91	270.05
Local	MARTA 121	328.71	10.65	13.5	325.86
Local	MARTA 121-	1131.94	0.75	13	1119.69
Local	MARTA 221A	492.18	85.64	10.39	567.43
Local	MARTA 221B	68.35	4.52	19.09	53.78

Table 100: I-285 South & Memorial Drive (Node 4160)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 419	904.54	0	223.1	681.44
Local	MARTA 121	312.71	15.98	0	328.69
Local	MARTA 121-	1119.69	12.48	0	1132.17
Local	MARTA 221A	567.43	105.78	0	673.21
Local	MARTA 221B	64.12	4.25	0	68.37

Table 101: Kensington Station (Node 19004)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Local	MARTA 107-	0	85.32	0	85.32
Local	MARTA 116	0	1.33	0	1.33
Local	MARTA 116S	0	0.54	0	0.54
Local	MARTA 121	0	312.72	0	312.72
Local	MARTA 21A	489.96	0.32	489.96	0.32
Local	MARTA 21B	0.08	79.79	0.08	79.79
Local	MARTA 221A	673.21	29.54	497.66	205.09
Local	MARTA 221B	23.38	60.94	20.21	64.11
Local	MARTA 9	0	48.18	0	48.18

Lindbergh Center

Table 102: Lindbergh Center Station (Node 19022)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GCT 103A	93.95	508.12	0	602.07
Express	GRTA 410	776.78	89.15	385.22	480.71
Local	MARTA 27B	0	110.55	0	110.55
Local	MARTA 30A	0	128.96	0	128.96
Local	MARTA 39A	0	643.78	0	643.78
Local	MARTA 5-	0	691.86	0	691.86
Local	MARTA 6-	0	999.09	0	999.09
Local	MARTA 6S-	0	999.09	0	999.09

Table 103: Monroe Dr and Piedmont Cir (Node 14916)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GCT 103A	138.56	16.69	73.21	82.04
Express	GRTA 410	458.81	22.04	55.65	425.2
Local	MARTA 27A	4.32	0	4.32	0
Local	MARTA 27B	0	3.01	0	3.01

Atlantic Station and Bellemeade

Table 104: Atlantic Station (17th St) (Node 12922)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	CCT 10C[38]	840.72	7.18	0	833.54

Table 105: Bellemeade Ave & Northside Dr (Node 14730)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	CCT 10C	840.72	68.34	39.42	869.64

Airport

Domestic Side

Table 106: Domestic Terminal (Node 3440)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 453	974.6	0	67.16	907.44
Local	AIRPORT E	0	0	0	0
Local	AIRPORT W	4.41	0	0	4.41

Table 107: Airport MARTA station (Node 3422)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 453	907.44	0	262.37	645.07
Local	AIRPORT E	0	732.95	0	732.95

[38] Note: Although other buses also run on 17th Street, they are coded in the general purpose rather than the bus lane, so they do not share the same node.

International Side

Table 108: I-75 HOV exit – south node (Node 9365)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 430	932.84	0	15.52	917.32
Express	GRTA 431	436.32	0	20.68	415.64
Express	GRTA 440	2387.43	0	5.6	2381.83
Express	GRTA 441R	104.94	2.55	1.8	105.69
Local	AIRPORT E	62.79	0	0.46	62.33
Local	MARTA 191B	0	12.43	0	12.43
Local	MARTA 194B	0	6.6	0	6.6

Table 109: I-75 HOV exit - north node (Node 15670)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 430	917.32	86.95	67.18	937.09
Express	GRTA 431	415.64	52.75	99.56	368.83
Express	GRTA 440	2381.82	124.49	121.39	2384.92
Express	GRTA 441R	131.47	0	26.53	104.94
Local	AIRPORT W	0	210.59	0	210.59
Local	MARTA 191A	165.42	0	165.42	0

Fulton Industrial

Table 110: I-20 East & Fulton Industrial Blvd (Node 6476)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 463	2245.46	74.45	165.69	2154.22
Express	GRTA 475-PC	91.91	49.85	4.75	137.01
Express	GRTA 476	1824.97	0	188.59	1636.38
Local	CCT 25S	214.63	3.37	7.19	210.81
Local	CCT 30	785.83	11.54	29.51	767.86
Local	CCT 30-	445.96	97.11	100.84	442.23
Local	MARTA 73A	608.83	67.34	0	676.17
Local	MARTA 73B	49.39	25.11	6.24	68.26

Table 111: I-20 West & Fulton Industrial Blvd (Node 6477)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 475-PC	87.26	10.34	5.69	91.91
Local	CCT 25N	144.77	13.16	0	157.93
Local	MARTA 73A	617.43	0	8.6	608.83
Local	MARTA 73B	68.26	0	0	68.26

Southlake Mall

Table 112: US-41 & Upper Riverdale Rd (Node 3357)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 440	2269.48	202.18	84.23	2387.43
Express	GRTA 441	1387.59	156.13	52.03	1491.69
Express	GRTA 441R	105.69	0	41.26	64.43
Local	MARTA 192	82.27	3.79	0	86.06
Local	MARTA 192-	94.76	0	29.36	65.4
Local	MARTA 196A	16.15	66.7	0	82.85
Local	MARTA 196B	312.53	0	214.34	98.19

Table 113: US-41 & Mt Zion Rd (Node 6202)

Mode	Route	Pax before	Boardings	Alightings	Pax after
Express	GRTA 440	2075.32	257.43	63.27	2269.48
Express	GRTA 441	1223.43	205.6	41.44	1387.59
Express	GRTA 441R	64.43	0	29.38	35.05
Local	MARTA 192	223.76	0	141.49	82.27
Local	MARTA 192-	65.4	0	0	65.4
Local	MARTA 196A	37.67	10.51	32.03	16.15
Local	MARTA 196B	98.19	4.02	8.3	93.91
Local	MARTA 197A	71.12	2.61	71.12	2.61
Local	MARTA 197B	0	22.74	0	22.74

APPENDIX I

MARTA PROPOSED PHASE 1 CHANGES

The tables below are from a document sent to the author by MARTA via email in early May 2015. They show proposed changes that MARTA plans to implement in Phase 1 as a result of its COA. The tables were copied directly from the document. These changes are draft in nature and subject to change (K. Hayden, personal communication, May 8, 2015). The author coded the changes into the model based on his best interpretation of them.

Table 114: "Arterial Rapid Transit (ART)" Phase 1 changes

Route	Route Name	Proposed Alignment Change	Frequency			
			Proposed		Existing	
			Peak	Base	Peak	Base
5	Piedmont/Roswell ART	No proposed alignment changes	10	10	15	20
39	Buford ART	No proposed alignment changes	10	10	12	15
78	Cleveland ART	No proposed alignment changes	10	10	15	20

Table 115: "Express Route Recommendations" Phase 1

Route	Route Name	Proposed Alignment Change	Frequency			
			Proposed		Baseline	
			Peak	Base	Peak	Base
240	Windward/Mansell	**New route** - Proposed to operate as Express service from Windward P&R to North Springs in peak direction peak period service	10	N/A	-	-
242	Morris/Deerfield	**New route** - Reverse commute service from North Springs Station to Morris/Deerfield	30	N/A	-	-
243	Alderman/Windward	– Formerly Route 143. Reverse commute service from North Springs Station to Alderman/Windward	30	N/A	-	-

Table 116: "Frequent Local Bus Service" Phase 1 changes

Route	Route Name	Proposed Alignment Change	Frequency			
			Proposed		Baseline	
			Peak	Base	Peak	Base
2 Short	Ponce de Leon SL	**New route -** Short lined between Midtown Station and Moreland; interlined with Route 1	15	15	35	50
12 Short	Howell Mill	Shorten to Collier	15	15	20	30
55	Pryor/Jonesboro	Merged with 155	15	15	20	25
95	Metropolitan	Extended along Virginia Ave to College Park Station, Atlanta Metropolitan State College loop discontinued	15	15	15	15
107	Glenwood	Serve Five Points via Bill Kennedy Way, Memorial Drive; serve Snapfinger Woods loop via Wesley Chapel	15	15	15	15
115 Short	Covington	New route - Frequent service to Panola Road from Indian Creek Station	15	15	-	-
116 Short	Redan	New route - Frequent service to Panola Road from Kensington Station	15	15	-	-
162	Headland	Alignment consolidated along Alison Court, truncated at Stone Creek Apartments	15	15	15	20

Table 117: "Supporting Local Bus" Phase 1 changes

Route	Route Name	Proposed Alignment Change	Frequency			
			Proposed		Baseline	
			Peak	Base	Peak	Base
1	Marietta	Consolidate alignment onto Huff Road and Marietta Boulevard, terminate at North Avenue Station via Marietta Street, Tech Parkway, North Avenue	15	30	20	35
2 Long	Ponce de Leon LL	Long line service to East Lake Station via Ponce De Leon	30	30	35	50
4	Moreland	Alignment extended to meet Route 78	30	30	35	60
12 Long	Howell Mill	No proposed alignment changes	30	30	20	30
21	Memorial	Operates between Inman Park Station and Indian Creek Station via Moreland Avenue, Memorial Drive, and Kensington Road	15	30	20	30
37	Defoors Ferry	Terminate at Arts Center Station	30	30	40	40
42	McDaniel/ Pryor	Alignment consolidated along Pryor Rd	30	30	30	30
64	Beecher	**New route** - Created from Beecher section of Route 68, operating between West End Station and Beecher/Mays/Cascade; consolidate alignment along Beecher Street	30	30	-	-
68	Joseph E Lowery	Serves Joseph E Lowery Boulevard between Bankhead and West End Station	30	30	30	30
84	Washington	Consolidated with Route 82, alignment consolidated along Washington, route terminates at Old Fairburn/Welcome All	30	30	20	45

Table 118: "Supporting Local Bus Route" Phase 1 changes continued

Route	Route Name	Proposed Alignment Change	Frequency			
111	Snapfinger Woods/ Hillandale	Terminates at Wesley Chapel/Snapfinger Woods loop	30	30	20	30
115 Long	Covington	Extends to Turner Hill Rd	30	30	15	20
116 Long	Redan	Serves Lithonia Main St to Mall at Stonecrest	30	30	20	25
117	Panola/ Rockbridge	Extend along Decatur Road to Winn Way	15	30	15	30
119	Hairston	Realign to serve Hairston, terminate at Wesley Chapel/Snapfinger Woods loop and Memorial	30	30	40	40
140	North Point	Off-peak direction/off-peak service will serve North Point Parkway and Windward P&R via Avalon; Alpharetta service via Haynes Bridge discontinued	30*	30	15	15
178	Hapeville	Alignment consolidated along Hapeville/Browns Mill and extended into Hapeville	30	30	20	30
189	Old National/ Jonesboro	Serves Godby segment from Route 89	15	30	20	35
193	Sylvan/ Springdale	Rerouted into Oakland City via Dill, merged with 172 to serve East Point Station via Springdale	30	30	35	35

Table 119: Discontinued routes in Phase 1

Route	Region
148	North Fulton
172	South Atlanta
155	South Atlanta
82	South Fulton
102	West DeKalb

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